SPACE TEST PROGRAM (STP)

EXPERIMENTERS' GUIDE

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Space Test Program
Detachment 12
Space and Missile Systems Center
Air Force Space Command

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1. INTRODUCTION

1.1 Experimenter's Guide Purpose

This document is a technical and programmatic guide for use by experimenters or Principle Investigators (PIs) wishing to take advantage of Space Test Program (STP) provided flight services. This guide summarizes the important steps of the process of defining, obtaining flight approval, designing, building, testing, and operating an experiment in space. Additionally, discussions often refer to more detailed documents for PI reference in documenting a space experiment for an STP mission. Thus, this document provides guideline information for investigators to use in the early planning stages of their respective experiments.

1.2 The Space Test Program Organization

1.2.1 Space Test Program Mission

STP is a Department of Defense (DoD) activity under Air Force (AF) executive management, which provides spaceflight for the entire DoD space science and technology community. The Space and Missile Systems Center (SMC), Detachment 12 (Det 12) manages STP. STP advances space system technology by providing spaceflight and related services for experiments generated within the entire DoD space science and technology community. Services provided by STP include flight requirements development, mission design, manifesting assistance, spacecraft design, fabrication, test, experiment integration, launch vehicle (LV) integration, launch services, ground and flight safety support, flight support, orbital operation, and transmittal of data to PIs for analysis/dissemination. STP provides these services to approved Space Experiments Review Board (SERB) payloads. Non-SERB payloads can also obtain the same services on a reimbursable basis.

The complexity of experiments flown by STP spans a wide range, from basic research through advanced technology payloads. The result of these experimental space demonstrations is substantial risk mitigation at relatively low cost for new space systems or sub-systems technologies, concepts, and designs before they are incorporated into operational systems.

STP's objective is to fly the optimum number of experiments from the DoD SERB priority list consistent with priority, opportunity, and available funds. This is accomplished by numerous methods to gain spaceflight for experiments: Shuttle/International Space Station (ISS); Auxiliaries, which include Piggybacks and Secondaries; Dedicated Launches, Sounding Rockets, Balloons and KC-135 flights.

The most cost-effective method is through collaboration with the National Aeronautics and Space Administration (NASA) to fly experiments on the Space Shuttle and ISS. Space Shuttle experiments operate in either the pressurized middeck of the Shuttle crew cabin or the cargo bay. Cargo bay experiments are attached to the Shuttle or ejected into space as free flyers. ISS experiments will also operate in both the pressurized crew cabin or attached to fixed points on the exterior.

STP also flies experiments as piggyback and secondaries. Piggybacks are experiments placed on existing spacecraft of various agencies and companies of the U.S. and other countries. These receive services (power, communications, etc) from the host spacecraft. Secondaries are spacecraft experiments that are placed on an existing launch vehicle.

For experiments with unique orbital or physical requirements that can only be met by free-flying spacecraft, STP contracts for spacecraft development, experiment integration, and launch service.

1.2.2 Space Test Program Organization

As shown in Figure 1.2-1, STP (ST) executes its functions through three divisions: Spaceflight Mission Design (STX), Spacecraft Acquisition (STS) and Shuttle/ISS (STH).

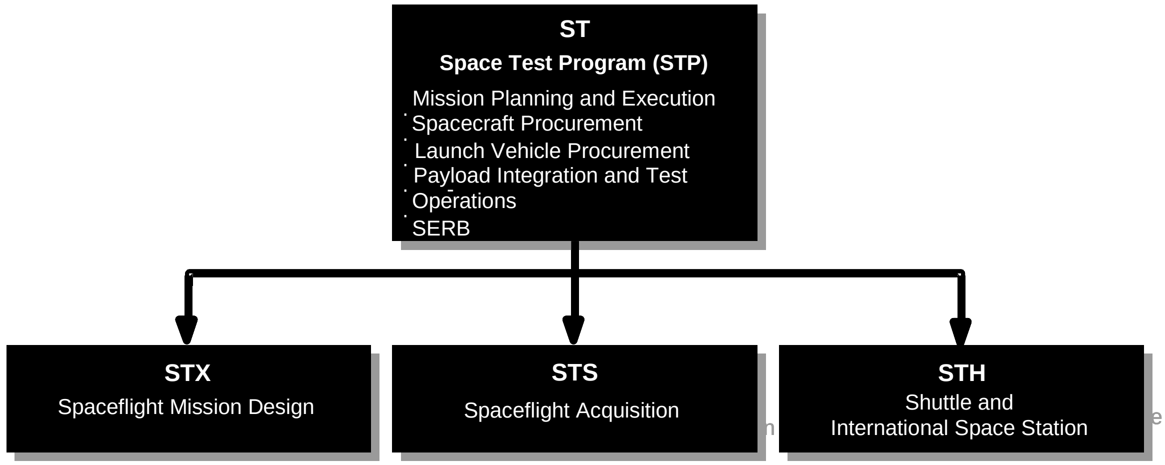

Figure 1.2 -1. ST Organization

1.2.2.1 Space Flight Mission Design (STX)

STX is the Det 12/ST division responsible for overall SERB support, Expendable Launch Vehicle (ELV) and Shuttle/ISS mission design and flight planning activities. STX is also the STP contact for all SERB PIs. STX's efforts are based on the prioritized SERB list, STP's budget, and available flight opportunities. During the initial stages of experiment selection, STX is the primary contact for the PI. STX is primarily responsible for developing Evolved Launch Vehicle (ELV) spaceflight requirements and Memoranda of Agreements (MOA) with experiment sponsors and other agencies (e.g., host vehicle agencies for auxiliary missions). In addition, STX prepares Space Flight Plans (SFP) for the Under Secretary of the Air Force, Director of Space Acquisition (SAF/USA) and transitions the mission management function to STS when appropriate. In addition, STX coordinates and monitors experiment payload development and supports flight operations planning activities. Piggyback mission are typically kept in STX for their mission development and execution.

1.2.2.3 Spaceflight Acquisition (STS)

After an experiment is manifested on an ELV flight, the mission/experiment is handed off to STS. The PI will work primarily with STS for the remainder of the program's life cycle. STS activities include all aspects of mission management, including experiment integration as well as the management of the design, development, integration, and test of STP spacecraft and LVs (as appropriate). In addition, STS manages various operations readiness and execution activities in conjunction with SMC Det 12/VOF, Vehicle Operations Division or the designated operations center.

1.2.2.2 Shuttle/ISS Payload Missions (STH)

Once STX and STH have made the determination to fly an experiment on a Shuttle/ISS mission, STH serves as the single point interface between the PI and NASA, assisting PIs with the various tasks involved in obtaining a flight on the Shuttle or ISS. Assistance includes developing spaceflight requirements and MOAs with experiment sponsors, selection of a suitable Shuttle/ISS platform, guidance in preparing for the NASA phased safety reviews, and assistance with payload integration and operations on Shuttle/ISS. STH is the STP division responsible for human spaceflight mission design, integration, safety, and operations activities. STH's efforts are based on the prioritized SERB list, STP's budget, and available human space flight opportunities.

1.3 STP Mission Life Cycle

The first step for the PI is to brief the SERB and become ranked on the SERB list. This process is described in Section 2. This section provides an overview of the STP mission life cycle. Although there is variation from one program to another, the typical mission life cycle consists of three basic phases: Mission Design, Mission Development, and Mission Execution. The events, procedures, and documents that comprise the mission phases form an overall process that covers the entire life of a mission. Figure 1.3-1 shows a representation of the life cycle of an STP mission. Table 1.3-1 provides a summary of documents involved in the program stages.

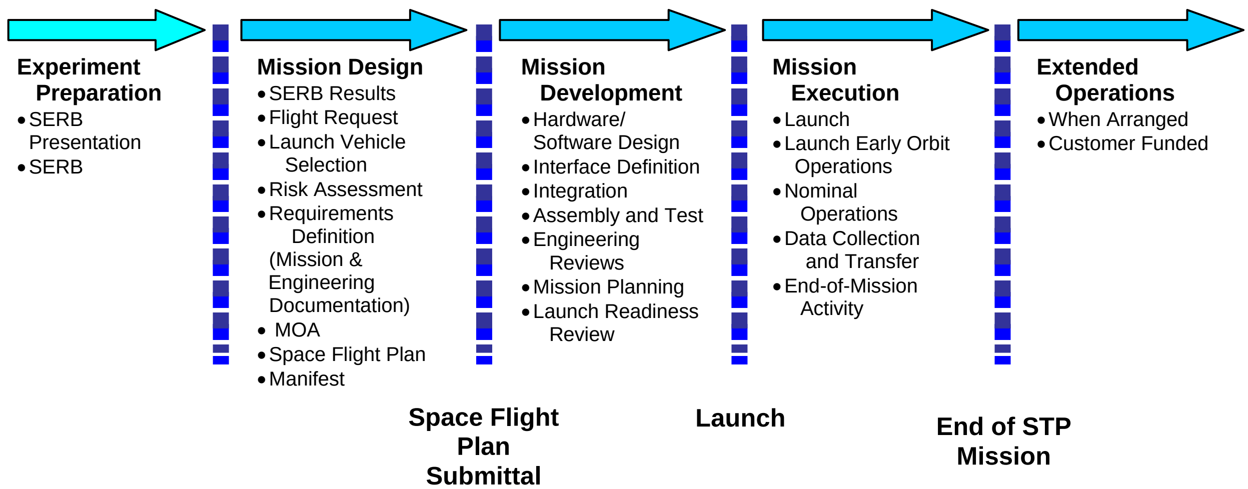

Figure 3.1-1 STP Mission Life Cycle Activities

1.3.1 Mission Design and Startup

Based on the SERB's Experiment Priority List, STP will "bundle" or assemble a complementary (if possible) set of experiments to fly as a single mission. The availability and priority of individual experiments, funding considerations, science "windows," etc., all drive this process. Some considerations in assembling experiments into a mission include overall priority of a given experiment or experiment package; mission complexity; experiment(s) to be manifested as primary or secondary payloads; orbit requirements for experiment science; experiment funding status; and other flight opportunities. During Mission Design, either STX or STH manages the mission depending on whether it is an ELV or Shuttle/ISS mission.

The mission definition and design process also includes the following:

1.3.1.1 For Auxiliary/ELV Missions:

- Developing the Experiment Requirements Document (ERD).
- Developing the Mission Requirements Document (MRD).
- Developing the Technical Requirements Document (TRD).
- Developing MOAs with PIs, launch vehicle providers and mission operations providers
- Developing a Preliminary Operations Concept.
- Generating a Preliminary Mission Risk White Paper (PMRWP).
- Determining booster availability through a LV Study

- Surveying contractual mechanisms for acquisition of the space vehicle (SV)
- Generating a preliminary, top-level mission schedule
- Generating and submitting a Space Flight Plan (SFP) for executive approval.

Table 1.3-2 lists key supporting documentation, responsibility, and recipient(s) for Auxiliary/ELV missions.

Table 1.3-2: Key Auxiliary/ELV Documentation

Document	Responsible Party	Delivered To
DD 1721 Flight Request and DD 1721-1 Executive Summary	PI	SAF/USAL
Experiment Requirements Document (ERD)	PI	STP
Mission Requirements Document (MRD)	STP & PI	STP
Technical Requirements Document (TRD)	STP & PI	STP
Funding and Support Certification	PI	STP
Experiment MOA	STP	STP
Ground Ops MOA	STP	STP
Launch Vehicle MOA	STP	STP
Preliminary Mission Risk White Paper (PMRWP)	STP	STP
Space Flight Plan (SFP)	STP	SAF/USA
ICD- Experiment to Spacecraft	SV Contractor	PI
ICD- SV to LV	LV Contractor	All Parties
Missile System Pre launch Safety Package (MSPSP)	LV Contractor	Launch Range
Software Development Plan	SV Contractor	STP
Software Design Document	SV Contractor	STP
Ground Mission Requirements Document (GMRD)	STP	Ground Ops Provider
Ground Specification Document (GSD)	STP	Ground Ops Provider
Ground ICD (GICD)	STP	Ground Ops Provider
Experiment Operations Plan (EOP)	STP	Ground Ops Provider
Space Vehicle Handbook (SVH)	SV Contractor	Ground Ops Provider
Orbital Operations Handbook (OOH)	SV Contractor	Ground Ops Provider
Command & Telemetry Handbook (C&TH)	SV Contractor	Ground Ops Provider
AFSCN Documentation	STP & Ground Ops Provider	STP & AFSCN
System Test Plan	SV Contractor	STP
Mission Operations Plan	STP	Ground Ops Provider
End of Life (EOL) Plan	STP	STP
DD 250 SV Transfer to the Government	SV Contractor	STP
DD Form 1721-2 or Final Report	PI	STP
DD 250 Contract Close –Out	SV Contractor	STP

1.3.1.2 For Shuttle/ISS:

- Developing the Payload Requirements Document (PRD)
- Preparation and submittal of Form 1628 Request for Space Flight
- Developing Memorandum of Agreements (MOAs) with PIs
- Target Launch date identification and initial manifest and requirements discussions held with NASA
- Generating and submitting a Space Flight Plan (SFP) for executive approval
- NASA HQ ranks and adds payload to their priority list

Table 1.3-1 lists key supporting documentation, responsibility, and recipient(s) for Shuttle/ISS missions.

Table 1.3-1: Key Shuttle/ISS Documentation

Document	Responsible Party	Delivered To
DD 1721 Flight Request and DD 1721-1 Executive Summary	PI	SAF/USAL
Payload Requirements Document	PI	STP
Payload Integration Agreement (ISS) or Payload Integration Plan (Shuttle)	STP & PI	STP
Funding and Support Certification	PI	STP
Experiment MOA	PI & STP	STP
Space Flight Plan	STP	SAF/USA
Flight Safety Data Package	STP & PI	STP
Customer Payload Requirements	STP & PI	STP
Ground Safety Data Package	STP & PI	STP
Structures Verification Plan	STP & PI	STP
Fracture Control Plan	STP & PI	STP
Mechanical Systems Verification Plan	STP & PI	STP
Payload Data Library (ISS)	STP & PI	STP
Interim User Requirements (ISS)	STP & PI	STP
User Requirements Collection (ISS)	STP & PI	STP
Payload Integration Plan/Annexes (Shuttle)	STP & PI	STP
DD Form 1721-2 or Final Report	PI	STP

1.3.2 Mission Development

The starting point for STP Auxiliary/ELV mission development is somewhat subjective, but it is generally formalized at the time of SFP approval. STX leads the early mission definition phases, along with STS participation, to assist in feasibility studies. Management of the mission transitions from STX to STS for the Mission Development Phase.

Mission development is the process of building a mission. Based on STP obtaining authorization to expend funds on a mission once an SFP is approved, STP begins the lengthy activities that consume the greatest share of STP's annual budget:

- Developing and producing flight hardware, flight software, and the mission operations system
- Developing operations requirements documents
- Integrating and testing the experiment(s) and host spacecraft
- Conducting operations readiness events
- Maintaining experiment and space vehicle development, integration, and test, and reporting system status at various executive readiness reviews.

During the mission development phase, all or some of the following activities are accomplished. The activities below represent the classic STP free-flyer mission. The scope of activities is much less when STP is developing an auxiliary mission.

- Producing a total mission cost estimate and associated fiscal year(s) budget profile, and updates as required.
- Developing an acquisition plan and obtaining executive approval
- Obtaining sufficient funding to pursue mission development
- Developing Request for Proposal (RFP) package (if applicable)
- Conducting a proposal evaluation (if applicable)
- Base lining the mission requirements, design interfaces, and operations concept
- Coordinating system configuration and contract changes
- Evaluating and reporting program cost, schedule and technical performance, adjusting as required
- Performing environmental and integrated system test of the SV
- Generating nominal and contingency mission operations procedures
- Mission Operations Rehearsals
- Performing system level end-to-end tests and compatibility tests
- Processing the SV at the launch base
- Integrating the SV into the LV

During the course of mission development, a multitude of meeting and reviews, such as Technical Interchange Meetings (TIMs), System Readiness Review (SRR) Preliminary Design Review (PDR), Critical Design Review (CDR), and Mission Readiness Review (MRR) occur. PIs will be expected to participate in these meetings and reviews.

Unique activities associated with Shuttle/ISS payloads include the following:

- Kickoff TIM to review cargo bay processes and integration requirements
- Integration plan and schedule for payload

- PRD submitted to STP for review
- STP and PI Submits Phase 0/1 Safety Data Package
- Phase 0/1 Safety Review held at Johnson Space Center (JSC)
- Shuttle/ISS Payload Integration Plan (Shuttle) or Payload Integration Agreement (ISS) and Interface Control Document (ICD) prepared
- Payload manifested on Shuttle or ISS
- STP and PI submits Phase 2 Safety Data Package
- Phase 2 Safety Review held at JSC
- Flight hardware development and testing completed
- STP and PI submits Phase 3 Safety Data Package
- Phase 3 Safety Review held at JSC
- Crew familiarization and training conducted
- Payload delivered to JSC and certification tests performed
- Payload delivered to Kennedy Space Center (KSC) and functional test performed
- Payload installed into Orbiter and Integrated Vehicle Test performed

1.3.3 Mission Execution

The starting point for STP Mission Execution (flight support for free flying space vehicles) is generally recognized as the launch of the SV. STP typically has coordinated very closely with the organization(s) providing the infrastructure for mission operations (typically SMC Det 12/VOF, the office that operates the Research, Development, Test, and Evaluation (RDT&E) Support Complex (RSC)). For free-flyer missions, STP provides operation crews to oversee mission operations during the launch and early orbit Low Earth Orbit (LEO) phase and critical SV/experiment initialization activities during later mission phases. Even when STP is not present in the mission operations center, it is responsible for mission operations and therefore remains cognizant of, and reports on, mission performance, anomaly resolution, and other issues.

Mission execution is the process of conducting a space test mission, including space experiment operations. Most STP missions are divided into three mission phases: LEO, nominal mission operations, and end of mission activities. LEO consists of initial contact and checkout of the spacecraft. Nominal operations consist of activities directly related to accomplishing the mission goals, as well as health and status monitoring. End of mission activities include disposition of the spacecraft, final reports and reviews, and contract closeout. When experiment operations are mutually exclusive, the nominal mission operations phase may be divided into multiple sub-phases in order to protect the viability of all experiments. Piggyback mission execution is relatively simpler in scope and typically involves coordination of experiment data collection activities with the primary payload operations control center. Shuttle/ISS mission operations typically performed by NASA mission specialists and supported by STH, are described in STH's project management guides. Due to the unique nature of human spaceflight, Shuttle/ISS operations are tailored to each specific payload and mission. Contact STH personnel for specific inquiries for conducting Shuttle/ISS operations.

Other tasks accomplished during the mission execution phase include the following:

- Coordinating special observation support during the LEO phase
- Developing and coordinating daily and long-range mission activity schedules

- Conducting spacecraft contingency operations and anomaly recovery
- Reporting daily mission status and issues
- Managing experiment data collection and routing activities
- Recording appropriate mission performance metrics for incentive payments
- Providing mission status and performance information for public release

2. EXPERIMENT PREPARATION

2.1 Form 1721 Preparation

To be considered for flight on an STP sponsored mission, a PI must complete a formal request for flight. The STP Flight Request (DD Form 1721) and the STP Flight Request Executive Summary (DD Form 1721-1) are the official means by which a PI requests a space flight. The SERB uses the information on these forms to generate an initial prioritization. After formal SERB experiment ranking, STP uses the information to make preliminary evaluations of potential flight modes for the experiment and conceptual missions comprised of multiple experiments.

Non-DoD agencies, e.g., Applied Physics Laboratory or NASA, may submit spaceflight requests directly to the DoD SERB if their experiments are DoD relevant and they have a DoD agency sponsor. The DD Form 1721 and 1721-1 and instructions for their completion are found in Attachments C and D respectively. These forms must be submitted electronically. STP may be contacted if there are any questions, or for a review of completed paperwork prior to the SERB.

2.2 Pre-DoD Space Experiments Review Board

Before the DoD SERB, the Army, Navy, and Air Force conduct service-level SERBs to preview the experiments proposed for later nomination to the DoD SERB. Other DoD agencies presenting multiple experiments for consideration also prioritize their experiments. Many of the experiments are the result of the service laboratories' investigation of future systems to improve the war fighting capabilities of their respective service commands. Within the AF, the SMC Transformation Directorate (SMC/TD) approves AF R&D spaceflight requests. Within the Navy, N09, Office of the Chief of Naval Operations, approves Navy R&D spaceflight requests. Within the Army, SARD-TC (Director, Advanced Concepts and Space) approves Army R&D STP requests. Non-service DoD agencies, e.g., Missile Defense Agency (MDA) or Defense Advanced Research Projects Agency (DARPA), submit their requests directly to the DoD SERB. Normally the Forms 1721 and 1721-1 and SERB Briefings are used to coordinate the experiment through the agency and/or service SERBs.

As an experiment progresses through pre-SERB activities, STP is often in contact with PIs, providing them with constructive comments to their briefings and 1721s to help them compete as effectively as possible. Figure 2.2-1 shows the pre-SERB and SERB process relationships and outputs.

2.3 DoD Space Experiments Review Board

Coordination between STP and the PI continues as an experiment progresses through the SERB process. Much of the coordination between STP and the PI is reflected in the development of briefings for the SERB. For instructions on developing SERB briefings, refer to Attachment E.

The SERB reviews all the DoD-sponsored science experiments submitted via the service boards (i.e., Army, Navy, and Air Force) and other related organizations, e.g., the MDA, and prioritize them according to various criteria. The experiment ranking is based on military relevance 60%, service priority 20%, and technical merit of experiment 20%.

The DoD SERB consolidates and prioritizes a list of experiments for the current year, which replaces the previous list. STP uses this list as the starting point for its efforts to develop missions to fly the experiments. Any given STP mission may be a collection of one or more experiments. Being on the list does not guarantee that the experiment will be funded or that the experiment will be built and flown. The prioritized experiment list is released two to four weeks after the SERB meeting.

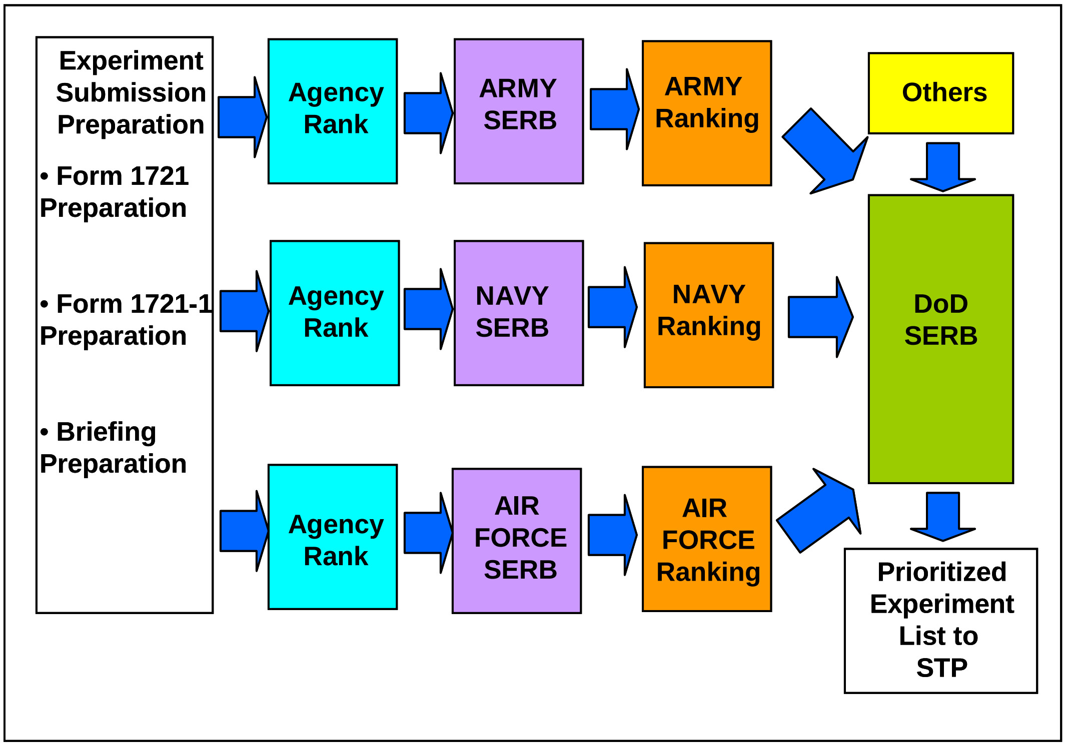

Figure 2.2 - 1. The SERB Process

In special cases, an experiment may request consideration outside the normal review process. Experiments may be approved and added in mid-cycle to the SERB list; however, they are placed at the bottom of the ranked list and must be formally presented and ranked at the next SERB. Experiments will be considered for mid-cycle insertion only if they are of great military importance or have an immediate flight opportunity that would be missed if they had to brief the regular SERB.

3. DEFINING THE MISSION

3.1 Bundling Study

STP conducts preliminary experiment bundling immediately after the DoD SERB is concluded, based on the requirements presented during the SERB. This involves grouping experiments into potential flight packages based on similar orbit requirements, experiment availability dates, experiment science compatibility/synergy, and mission operation concepts. This study is based on the 1721, so it is very important to fill out the 1721 correctly and completely. After this bundling study the mission managers from STH and STX meet to divide the list into three categories: Shuttle/ISS, Auxiliary/ELV, or either. The mission managers have familiarized themselves with the experiments via the briefings, 1721s, and/or discussions with the PIs. Experiments that fall in the either category could be flown on either the Shuttle/ISS or an Auxiliary/ELV. When one organization finds a flight opportunity for an experiment, it informs the other and they cease all work (if any) on the subject experiment. Experiments marked for STH will then only be worked by STH and STX will work experiments for Auxiliary/ELV missions.

3.2 Mission Definition

Although there are some differences between the Auxiliary/ELV and Shuttle processes, recall that there are three basic elements to the Spaceflight Plan from the perspective of the PI, regardless of the flight mode:

- A declaration of experiment requirements
- A formal commitment to funding and support
- An agreement to conduct all required activities in support of the mission

3.2.1 Auxiliary/ELV Mission Definition

The steps involved in manifesting an experiment on an Auxiliary/ELV mission are shown in Figure 3.2-1.

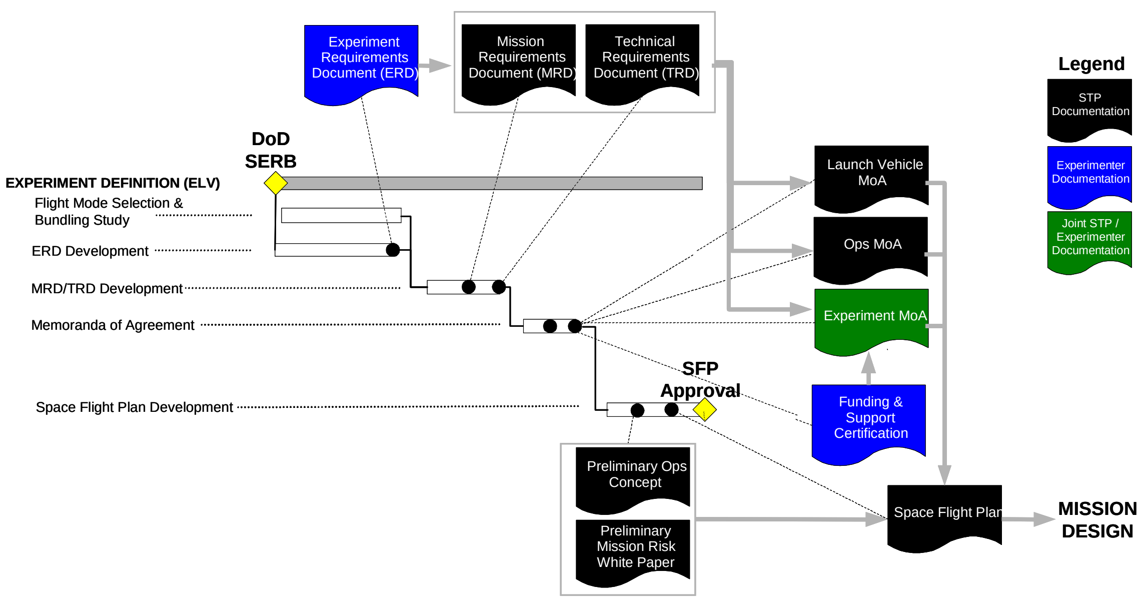

Figure 3.2-1. Experiment Manifesting on an ELV

3.2.1.1 Experiment Requirements Document (ERD)

Primary Responsibility: PI

The ERD documents the experiment requirements. The PI conveys to STP the experiment description, objectives, rationale, and requirements during SV development, integration, test, launch, and on-orbit operation. The PI signs the ERD.

The ERD documents the experiment requirements under best-case conditions without consideration of mission constraints such as cost, conflict from other experiments, STP budget availability, etc. It identifies critical requirements, prioritizes the requirements, and indicates trade space to facilitate discussions and trades when the experiment is bundled with other experiments for a mission manifest. The ERD must be sufficiently detailed for STP to fully understand the minimum requirements necessary for experiment success and the context of adding additional requirements if resources permit.

The following items are typically documented in the ERD:

- Purpose, background, and rationale
- Experiment objectives
- Science objectives
- Flight execution objectives
- Physical descriptions of the experiment and interfaces
- Orbit and flight duration requirements
- The experiment orbital operations requirements
- Hardware and software requirements
- Ground operations requirements
- Experiment data processing and archiving requirements
- Potential trade spaces regarding either science requirements or operational objectives, i.e. desirable versus mandatory
- Command/telemetry requirements
- Operating constraints (i.e., temperatures, power, etc.)
- Description of any known contingency scenarios

In addition, an overall timeline or sequence of events for specific types of observations is included along with systematic actions. Particular attention is devoted to showing the relationship between/among various steps (e.g. relative timing, dependencies, coordination required, etc.). Appropriate alternate sequences and timelines are provided. For instructions on how to develop an ERD, refer to the ERD template in Attachment F.

3.2.1.2 Mission Requirements Document (MRD)

Primary Responsibility: STP with PI support

The MRD defines the overall mission requirements and constraints as compiled by STP from the individual ERDs. It contains the driving set of requirements for mission design, system acquisition, mission planning, and operations execution phases of the mission. It typically contains:

- Identification of experiments/payloads;
- Orbit requirements
- Integrated mission timeline
- Individual experiment objectives
- Mission priorities
- Mission success criteria

The MRD is STP's official response to the ERDs that identifies any required compromises to the experiment objectives/requirements to be compatible with a specific flight. The MRD defines one specific flight that may or may not satisfy all of the experiment objectives documented in the ERD i.e. multiple flights may be needed to satisfy all of the experiment's objectives. However, one MRD may cover multiple ERDs.

The MRD is appended or referenced in a RFP for mission flight hardware/software. It includes required flight operations support as the official approved set of payload mission requirements. Any non-payload related requirements such as spacecraft reliability, training for the Mission Control Force, etc., would be specified in a separate document. Any subsequent mission decisions that contradict the MRD will require that a revision of the MRD be processed and approved by all signatory parties.

The MRD is a binding document between STP and the PI(s) and may be attached to an RFP or other contractual document. Approval of the initial MRD will be required before signature of the MOA and submission of an SFP package for approval.

3.2.1.3 Technical Requirements Document (TRD)

Primary Responsibility: STP with PI support

The TRD is prepared by STP to define technical and programmatic requirements or constraints imposed by STP on the spacecraft. Requirements come from various potential sources including the LV, experiment, or mission operations. Requirements may pertain to experiment to SC interfaces, SC to LV interfaces, test methods, schedule, launch environment, security, etc. The TRD defines one specific flight that may or may not satisfy all of the experiment objectives. Subsequent flights, if required, will need new TRDs.

3.2.1.4 Funding and Support Certification

Primary Responsibility: PI

Funding and development of the STP/PI MOA is contingent upon preparation of the Funding and Support Certification letter by the PI. The Funding and Support Certification letter is a letter of commitment from the PI's budgetary authority certifying that both funding and personnel are available and programmed to support the specific flight of the experiment. The document identifies funding requirements and sources by fiscal year. A plan to resolve any shortfalls between required funding and identified programmed funding must be provided. A template for a funding and support certification letter can be found in Appendix G.

The PI should consider funding requirements for a broad range of activities to include meetings, document preparation and inputs, test participation and monitoring, launch rehearsals and rehearsal planning, etc. Meetings requiring PI support and attendance are TIMs, PDRs, and CDRs for both individual experiments and for the SV.

3.2.1.5 Memorandum of Agreement

Primary Responsibility: STP (jointly signed by PI)

MOAs between STP and the PI(s) stating what each party is required to do and what each expects from the mission are necessary to avoid confusion and undocumented requirements. MOAs address roles and responsibilities, funding responsibilities, and schedules. Schedules should specify dates for the delivery of all items including test/flight hardware, software, and ground equipment. As appropriate, the roles and responsibilities of other organizations associated with the mission should be included. MOAs should also specify requirements for a Compliance Data Package and a pre shipment review of the experiment. Signed MOAs are required before STP submission of the respective SFP.

In addition to the STP/PI MOA, STP may prepare MOAs with the SC, LV, and/or Ground Operations providers if those are purchased via contract. Drafting of MOAs for these services is usually independent of the PI.

3.2.1.6 Preliminary Operations Concept

Primary Responsibility: STP

STP generates a preliminary operations concept before submission of an SFP package for approval. The preliminary operations concept documents the planned mission objectives, mission participants, facilities, command/data flow(s), and potential operational constraints/risks. The Preliminary Operations Concept is normally an attachment to the SFP and serves as the starting point for many of the operations documents developed for an STP mission.

3.2.1.7 Preliminary Mission Risk White Paper (PMRWP)

Primary Responsibility: STP

Part of the early mission design process involves STP preparing an assessment of the risk and feasibility associated with an STP mission. This is a crucial step in the approval of a planned mission. A PMRWP is required to inform executive AF management of the risks associated with a given STP mission at the time approval for the mission is sought. This paper accompanies an SFP package when submitted to the SMC Commander (SMC/CC) and SAF/USA for mission approval.

3.2.2 Shuttle/ISS Mission Definition

The steps involved in experiment definition on a Shuttle mission are shown in Figure 3.2-2. Relative to an ELV, the SFP for a Shuttle/ISS mission is completed relatively early, requiring only the Form 1721, funding & support certification, MOA, and NASA space flight request for the SFP to be approved.

3.2.2.1 Funding and Support Certification

Primary Responsibility: PI

The requirements for funding and support certification are similar for ELV and Shuttle missions. Refer to Section 3.2.1.4 for details on funding and support certification. The funding and support certification must be complete before a Memorandum of Agreement can be developed and signed.

3.2.2.2 Memorandum of Agreement

Primary Responsibility: STP (jointly signed by PI)

The purpose of the memorandum of agreement between STP and the PI is similar for both ELV and Shuttle missions. Refer to Section 3.2.1.5 for details on MOAs. One difference is that the MOA is developed with a Payload Requirements Document (PRD), which is similar to the ERD but is specifically used for Shuttle/ISS payloads. The development of a formal requirements document occurs within two to three months of the completion of the MOA, depending on the type of Shuttle/ISS platform used to host the experiment.

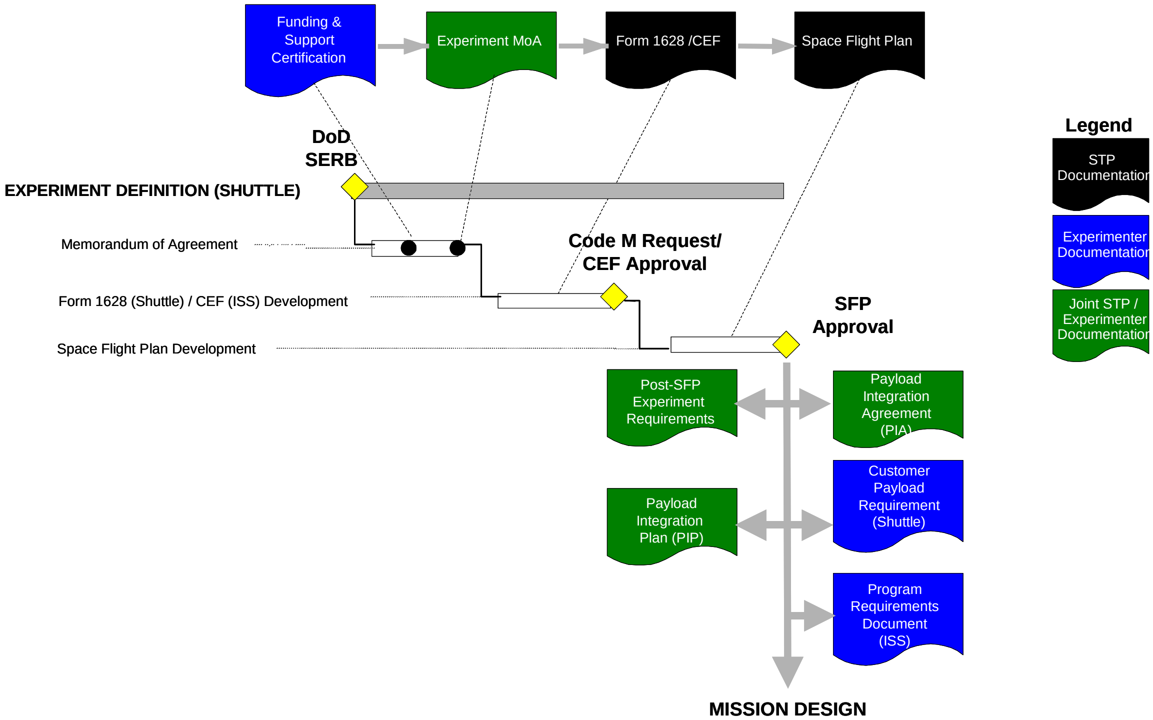

Figure 3.2-2: Experiment Manifesting the Shuttle/ISS

3.2.2.3 Experiment Requirements (Pre-Space Flight Plan)

Primary Responsibility: STP (with inputs from the PI)

The experiment requirements for a Shuttle/ISS mission evolve from a set of initial requirements defined in the Form 1721. STP uses these requirements to file a request for flight from NASA. A Payload Change Evaluation Form (for ISS) is submitted to NASA. NASA's acceptance and approval of the payload request clears the way for approval of the SFP.

STP signs the completed flight requests on behalf of the PI, based on experiment requirements. Flight requests include general information about the experiment, including:

- Brief description of experiment, including dimensions, weight, orbit requirements
- Experiment objectives
- Type of carrier (in the case of the Shuttle)
- Mission operations summary, including features/operations that would result in unusual Shuttle/ISS requirements

3.2.2.4 Experiment Requirements (Post-Space Flight Plan)

The documentation of experiment requirements may take several forms depending on the type of Shuttle/ISS mission flown, whether a carrier is involved, and whether the experiment will be placed on the ISS. For example, if the experiment is to be flown in the shuttle bay, the PI is required to submit a document called the Payload Requirements Document (PRD). The PRD communicates all basic requirements including the following:

- Mission Objectives
- Experiment description
- Definition of interfaces between the experiment and the shuttle carrier (electrical, mechanical, and thermal)
- A description of experiment operations, including critical procedures
- A description of ground operations requirements
- A list of potential safety hazards.

3.2.2.5 Payload Integration Plan (PIP) / Payload Integration Agreement (PIA)

STP works with NASA to develop the PIP, which is a reflection of experiment requirements from the Shuttle/ISS perspective. STP/NASA reviews the PI's requirements and places them in a form indicating what NASA will provide the PI based on Shuttle/ISS capabilities and opportunities. The PIP is NASA's official response to the PRD that identifies all experiment requirements that the Shuttle/ISS mission is able to meet. In cases where it is not possible to meet a particular requirement, STP will negotiate with NASA on behalf of the PI.

If the experiment is destined for the ISS, NASA will develop a PIA that serves a similar purpose as the PIP: The PIA is NASA's official response to the PRD that identifies all experiment requirements that the ISS is able to meet. As with the PIP, STP will negotiate with NASA on behalf of the PI in cases where it is not possible to meet a particular requirement.

The PIP and PIA are official mission requirements, and any changes to these requirements must be formally coordinated with NASA through change requests. If the PI needs a change in requirements, he must approach STP, and STP in turn will coordinate the change with the appropriate NASA authority.

If an experiment is to be flown on the ISS, requirements are entered into a series of electronic databases, such as the Payload Data Library and the Interim User Requirements Collection. The equivalent set of Shuttle documents is the PIP Annexes.

3.2.2.6 National Aeronautics and Space Administration Payload Safety reviews (Shuttle/ISS only)

Safety reviews are held specifically for Experiments launched on Shuttle/ISS. These reviews ensure that the Experiment meets all Shuttle/ISS requirements through the systematic identification of hazards, the development of control methods, and the verification that the hazard controls have been successfully implemented. Depending on payload needs, not all the following documents may be required.

In preparation for each safety review, the PI must conduct a thorough safety assessment of the experiment including developing hazard reports. A hazard report summarizes the PIs approach for dealing with hazards as defined in the Shuttle/ISS requirements (i.e., identification, control, and verification). A hazard report can only address a single hazard, so there may be several hazard reports written for a given experiment. STP can assist the PI in the safety assessment and development of hazard reports per the STP-PI MOA

For Shuttle/ISS, there are two types of safety reviews: flight safety reviews and ground safety reviews. Flight safety reviews are conducted by the Payload Safety Review Panel at the JSC and occur in three or more phases with each phase occurring as the program advances. A Phase Zero or Phase One safety review typically occurs around the time of an Experiment's PDR. Phase Two safety reviews occur around the time of a PDR. A final Phase 3 safety review occurs after all payload hardware development has been completed and is normally scheduled within 2-3 months from launch. Ground safety reviews are conducted by KSC and generally begin at Phase Two concurrent with the Phase Two flight safety review.

To support the phased safety reviews, the PI is required to submit or provide input to STH–prepared Payload Safety Data Packages and other related safety documents as required, including:

- Structures Verification Plan (SVP). The SVP documents the structural analysis and verification plan to ensure that all payload structures are compatible with the Shuttle/ISS and that the payload will meet all of its mission objectives when subjected to anticipated load conditions. The SVP establishes an understanding between NASA and the payload provider on how the Space Shuttle Program payload structural requirements will be implemented and verified. It includes verification of payload structural strength and life integrity and strength verification for certain materials contained within the payload.
- Fracture Control Plan (FCP). The FCP defines the elements of the payload fracture control program and the responsibilities for managing and accomplishing them. The methods and procedures defined in this document satisfy the minimum fracture control requirements of NSTS 1700.7, *Safety Policy and Requirements for Payloads Using the Space Transportation System (STS)* and NASA-Standard (STD)-5003, *Fracture Control Requirements for Payloads Using the Space Shuttle*. These methods and procedures include, but are not limited to, the following:
    - Analysis and/or testing and inspection to determine fracture control classification and acceptability of hardware.
    - Control of materials, manufacturing processes, testing, design changes, and transportation to assure proper implementation of this plan.
    - Overall review and assessment of the payload fracture control procedures and results.
- Mechanical Systems Verification Plan (MSVP). The MSVP establishes an understanding between the payload developer and NASA on how the Space Shuttle Program payload mechanical systems requirements will be implemented and verified for the payload. This plan states the proposed method for verification of the mechanical systems design. Compliance with NASA mechanical systems verification requirements will be demonstrated in formal stress analysis and test reports as applicable for each system.

3.3 The Spaceflight Plan (SFP)

Defining a mission culminates with the approval of the SFP. The SFP is the formal authorization by SAF /USA to expend funds to execute the mission. STP prepares an SFP for each STP-supported mission flying SERB approved experiments.

The SFP contains the information shown in Table 3.3-1. The organization of primary responsibility is indicated in parentheses after each entry. Although STP is responsible for preparing the SFP, the PI must provide inputs, such as specific experiment requirements as well as a commitment to funding and support (see Section 3.2.1.4). In addition, the PI must negotiate a MOA with STP outlining specific organizational responsibilities. Some of the steps involved in developing the SFP vary depending on whether the experiment is flown on an ELV or on the Shuttle/ISS.

Table 3.3-1: SFP Contents

SFP Contents for Auxiliary/ELV Missions	SFP Contents for Shuttle/ISS Missions
▪ LV and launch date identification (STP) ▪ Experiment complement identification (STP) ▪ Individual experiment weights and complement weight (STP/PI) ▪ Launch window, orbital inclination, and altitude data (STP) ▪ Spacecraft and support equipment identification (STP) ▪ MOA(s) describing experiment responsibilities and the designated payload integration manager (STP) ▪ Funding & Support Certification (PI) ▪ STP budget by fiscal year, indicating portions for each program, including spacecraft development, payload integration, the LV, and launch and orbital support (STP) ▪ Preliminary Operations Concept (STP) ▪ Preliminary Mission Risk Assessment (STP) ▪ Mission Requirements Document (MRD) - based on PI inputs from the experiment requirements Document (ERD) (STP/PI) ▪ Technical Requirements Document (TRD) (STP)	▪ LV and launch date identification (STP) ▪ Experiment complement identification (STP) ▪ Individual experiment weights and complement weight (STP/PI) ▪ Launch window, orbital inclination, and altitude data (STP) ▪ Spacecraft and support equipment identification (STP) ▪ MOA(s) describing experiment responsibilities and the designated payload integration manager ▪ Funding & Support Certification (PI) ▪ STP budget by fiscal year, indicating portions for each program, including the funding for the specific program in the SFP (STP)

4. EXECUTING THE MISSION

The activities and processes involved in executing a mission will vary depending on a number of factors, including the complexity of the experiment, maturity of technologies flown on the mission, arrangement of other experiments flown on the same mission, the type of LV, etc. This section provides a general summary of these activities and processes.

Basic to experiment mission execution is the acquisition process performed for the Experiment/PI by STP for ELV missions. STP's system engineering process concentrates on the integration of disciplines, full experiment life cycle coverage, assurance of interface integrity, management of technical risks, and validation that the experiment and or spacecraft meet the needs and requirements. PIs should familiarize themselves with this process by referring to:

- Military Standard (MIL-STD) – 499A, Engineering Management
- MIL-STD - 499B, Systems Engineering

4.1 Design

4.1.1 Requirements Development

4.1.1.1 Top-Level and User Requirements

Experiment design encompasses all the steps required to develop a hardware and software configurations that will meet overall experimental objectives as documented in the MRD, PIP, or PIA. In addition, the successful design will properly function after integration onto the spacecraft without affecting other features/requirements of the integrated SV as documented in system level requirements, such as ICDs. Finally, the experiment must be safe according to requirements of the LV (such as in the case of the Shuttle/ISS).

From the perspective of the PI, mission requirements are documented in the form of the MRD / TRD (for ELVs) or, in the case of Shuttle/ISS, in the form of the PIP/PIA. The PI's role in developing these documents was described in Section 3.

4.1.1.2 Interface Requirements

In many cases, ICDs are used to document external requirements. LVs may have generic requirements documents and ICDs available to the payload or, depending on the complexity of the spacecraft or experiment, a unique ICD may be used to detail the requirements for a single spacecraft or experiment. The responsibility for developing an ICD may rest with either the PI or spacecraft/LV organizations as defined in the project's MOA. Teams must be careful to avoid duplication of requirements where more than one requirements document is involved. If an ICD is developed by the spacecraft/LV organizations, the PI might expect to see:

- Information on the loading environment (all environmental loading)
- Physical and functional descriptions of the SV / LV subsystems supporting the experiment
- Mass / volume constraints
- Descriptions of mechanical interfaces
- Descriptions of electrical and data interfaces
- Experiment command and telemetry capabilities and services
- Experiment power and thermal controls
- Electromagnetic Interoperability/Electromagnetic Compatibility (EMI / EMC) requirements
- Operating constraints/limitations

Other requirement documents are available from the spacecraft/LV organization, covering topics such as safety, configuration management, quality control, etc.

Shuttle/ISS safety requirements are worth noting because of the number and scope of requirements involved. These safety requirements may have a significant effect on the overall design in areas such as:

- Materials and process selection
- Structural / mechanical systems design
- Electrical systems design, notably the use of inhibits, circuit protection
- Battery design

All Shuttle/ISS safety requirements may be found on the website for the NASA/JSC Payload Safety Review Panel (http://jsc-web-pub.jsc.nasa.gov/psrp/). The key safety requirements document is NSTS 1700.7B, which can be found on this website. The PI should be familiar with these safety requirements if manifested on the Shuttle/ISS. Safety requirements may drive the design of an Experiment and the PI should coordinate with STP.

4.1.1.3 Subsystem and Component Requirements

The PI must review both internal and external requirements and analyze these requirements for their effect on detailed subsystem and component design. None of the previously mentioned requirements documents approaches the level of specificity required for detailed design, and it may be necessary for the PI to develop additional requirements to address top-level requirements flow down seen in Figures 4.1-1 and 4.1-2 and in Table 4.1-1. A requirement flow down will aid the PI in developing piece parts, programming software, or selecting components in order to meet higher-level experimental objectives. Experiment requirements typically needing added definition of details include:

- Power and thermal requirements and constraints
- Requirements for command and data handling (e.g., how many and what types of commands will the experiment use, and how much data the experiment produces for processing onboard the satellite, downlink to the ground, and processing on the ground)
- Weight and volume of the experiment, defined at the subsystem or component level to allow for management of these characteristics
- Experiment design margins
- Experiment science objectives
- Orbital operations (i.e., how the experiment will be operated when on-orbit)

Government software is acquired in accordance with DoD-STD-2167A. This standard establishes requirements to be applied during the acquisition, development, or support of mission-critical software systems. The requirements of this standard apply to the development of Computer Software Configuration Items to the extent specified in STP/spacecraft contract clauses, the Statement of Work, and the Contract Data Requirements List. While the PI normally does not have to follow DoD-STD-2167A, he should be familiar with its contents.

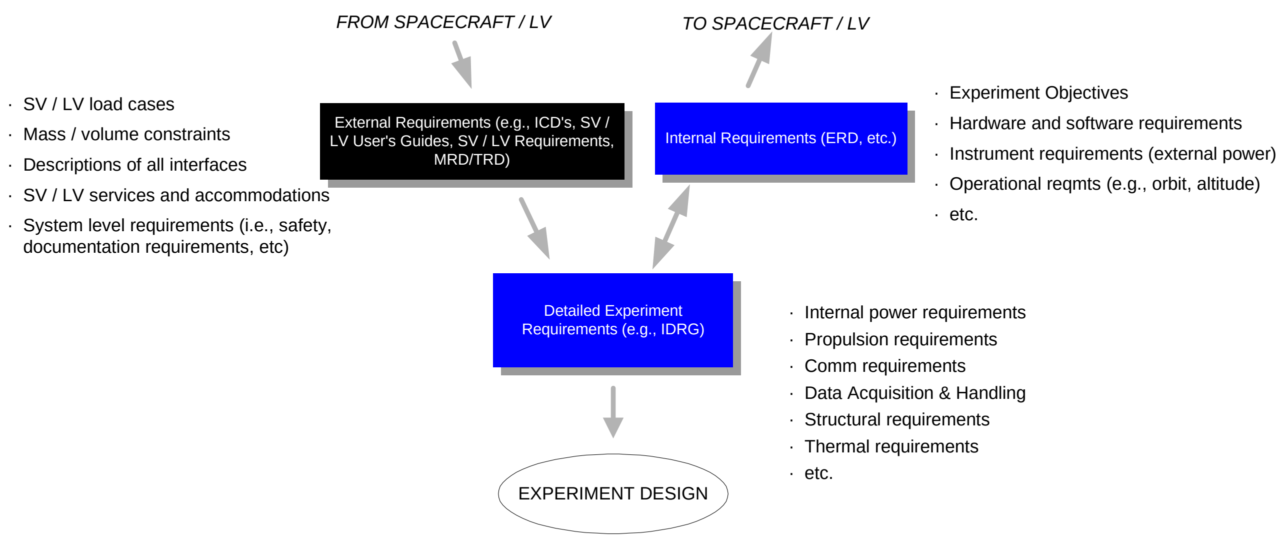

Figure 4.1-1: Internal and External Experiment Requirements (ELV)

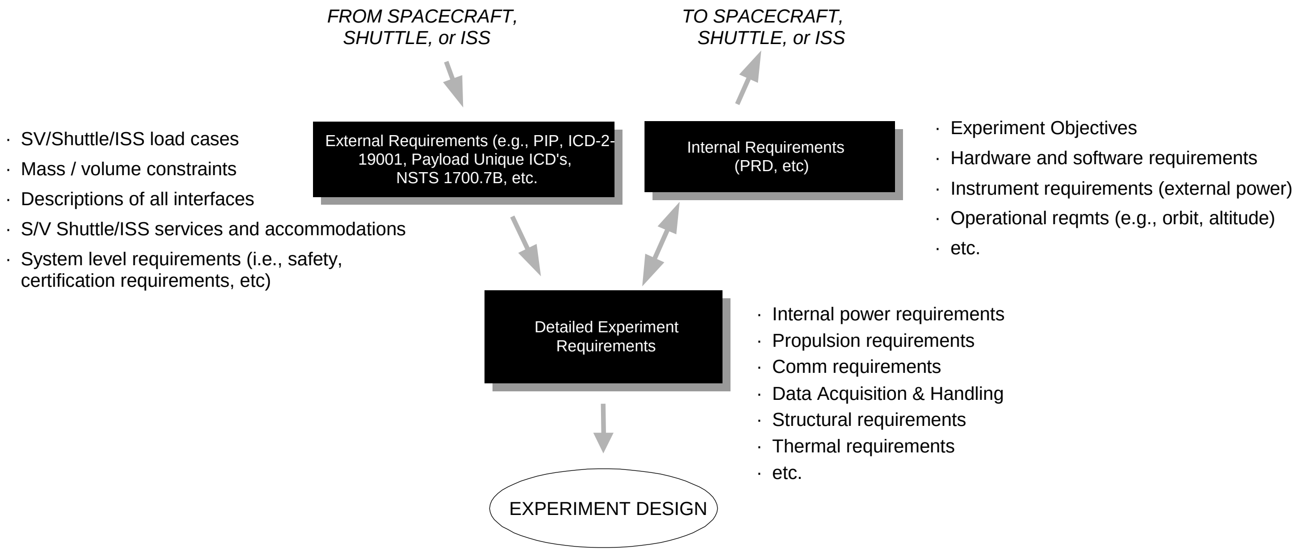

Figure 4.1-2: Internal and External Experiment Requirements (Shuttle / ISS)

For Shuttle/ISS experiments, the PI will be required to develop a safety requirements flow-down in the form of hazard reports for all Shuttle/ISS safety requirements as they pertain to the experiment. The hazard reports summarize all design features that must be incorporated to ensure that the experiment is safe per NSTS 1700.7B.

Table 4.1-1 Requirements Flowdown

Type of Experiment	Top Level Experiment Requirements	Detailed Experiment Requirements (i.e., Flow-Down)
On ELV	MRD / TRD (ERD) SV / LV Interface Control Document (ICD) SV / LV User 's Guides	Subsytem & Component Requirements and Specifications (e.g., Instrument Design Requirements & Guidelines – IDRG)
On Shuttle/ISS	PRD/PIP Core ICD (ICD -2-19001) Payload unique ICD CARS (for experiments mounted to Hitchhiker carriers) NASA Safety Requirements, including NSTS 1700.7B.	Subsytem & Component Requirements and Specifications Flight Safety Data Package Hazard Reports Structural Verification Plans Mechanical Systems Verification Plans Fracture Control Plans

4.1.2 Detailed Design, Parts, and Materials Selection

In designing hardware and software, the PI must focus on meeting a variety of requirements as discussed in the previous section. The actual sizing and selection of subsystem components and the formulation of a design to meet requirements is a complex undertaking driven by numerous considerations and design trade offs.

Experiment design should, utilize a conservative approach incorporating devices, components, materials, and processes previously flown. Unless the experiment evaluates new parts, materials, processes, or designs, one should not make them a part of the experiment. This is especially true of experiments intending to fly on Shuttle/ISS.

This document does not provide a comprehensive guide to experiment design. Table 4.1-2 identifies several major design considerations and associated military, and NASA sources that provide design guidance.

4.1.3 Design Documentation

4.1.3.1 Drawings and Specifications

Drawings and specifications are used to clearly define the Experiment hardware and software and are a reflection of top-level requirements and requirements flow down. The PI should thoroughly document hardware and software configurations in a drawing tree. Drawings will be required to support major design reviews such as PDRs, CDR, and formal safety reviews (Shuttle/ISS).

Table 4.1-2: Detailed Design Considerations

Requirement Type	Design Considerations	Design Resources
Schedule and cost	▪ Closely consider the use of purchased parts that have a long lead-time ▪ Design of hardware that is easy to assemble and easy to test will reduce total program cost and schedule ▪ Low cost is always a program goal, but consider the impacts of using low-cost parts that are not space-qualified. The total cost of such parts including additional effort required to qualify the part may be ultimately be higher.	
Basic fit and function	▪ Parts are installed and function as intended, both at a component and subsystem level.	
Mass properties / volume	▪ Minimize weight and volume. Mass properties should aggressively track at the experiment level and coordinated closely with the SV / LV organizations. Mass properties must be within constraints set by the SV / LV. ▪ Mass models may be required as specified in the STP-PI MOA. Mass models must accurately reflect the weight and CG of the experiment.	

Requirement Type	Design Considerations	Design Resources
Strength, durability, reliability	▪ Ensure that structure is adequately sized for stiffness as well as strength. Ensure that structure contains sufficient structural margin as defined by the program. ▪ Materials should exhibit good corrosion properties. Pay particular attention to material combinations that may cause galvanic corrosion. Exposed surfaces should be protected from corrosive environments ▪ Use materials with well-characterized strength/durability properties. Resist using brittle materials (consider the safety implications of using glass) ▪ Understand and adhere to program guidelines with respect to structural, mechanical and electrical redundancy. ▪ For recoverable experiments, there should be additional emphasis on fatigue-related design, such as the use of materials with a low stress-corrosion cracking threshold and the use of configurations with low stress concentrations.	▪ MIL-Handbook (HDBK)-5H ▪ NASA-STD-5003 ▪ Manned Space Flight Center (MSFC)- HDBK-527 ▪ MIL-HDBK-1547A ▪ NSTS 1700.7B ▪ NSTS 37329 ▪ MIL-STD 1522A ▪ NSTS-21000-IDD-SML, Rev C
Compatibility [w/ SV, LV, and other experiments]	▪ Hardware designed with up-to-date interfaces: mechanical, electrical, thermal, etc. ▪ Strive for low-out gassing materials. Some programs have limits on total mass loss (TML) and collected volatile condensable materials (CVCM) ▪ Strive for low radiated/conducted emissions and low susceptibility ▪ Electrical grounding requirements consistent with that of SV / LV	▪ Out gassing Database ▪ ICD-2-19001
Manufacturability, ease of assembly and test	▪ Where possible, design assemblies for easy manufacture. ▪ Be judicious in the use materials and processes that are inherently variable. Some parts and materials require tight process controls while some are more forgiving (e.g., composites vs. metals) ▪ Parts should be designed to facilitate testing and inspection as required (e.g., location of service and test ports, inspection ports, access panels). Service connectors should be easy to attach and remove.	
Manufacturing integrity / requirements for quality control	▪ Favor the use of components purchased from reputable suppliers with heritage in building spaceflight hardware. An example is the use of fasteners from program-approved suppliers.	
Certification and testing at the piece part level	▪ Work to minimize requirements for additional testing & certification. Examples are in the selection of battery cells: some cell types require more testing than others in order to be qualified for Shuttle/ISS use. ▪ If material strength properties do not exist, they must be developed	▪ NASA Preferred Parts List (PPL) ▪ JSC 23642
Safety	▪ All parts and materials subject to the safety requirements defined in NSTS 1700.7B. Shuttle / ISS safety should not be an afterthought. Safety requirements may fundamentally drive the design (e.g., use of electrical or mechanical inhibits, redundant systems, etc.). ▪ Pay close attention to requirements involving the following:	▪ NSTS 1700.7B ▪ NASA-STD-5003 ▪ JSC 26943 ▪ NSTS/ISS 13830 ▪ KHB 1700.7C

Requirement Type	Design Considerations	Design Resources
	▪ Sources of stored energy, such as batteries, pressure systems, ejection systems, heat sources, etc. ▪ Materials that could be considered fracture critical, such as glass or composites ▪ Materials with no documented strength data, particularly when the applications are structural in nature.	▪ NSTS 18798 ▪ JSC 20793

The PI should focus on developing drawings that clearly describe the configuration and function of the hardware. Drawings that are particularly useful during TIMs and design and safety reviews include the following:

- Envelope drawings showing the overall dimensions and physical interfaces of the experiment.
- Detail and assembly drawings of hardware that is heavily requirements driven. These drawings are generally associated with spacecraft rather than experiments (e.g., structural assemblies, battery box assemblies, etc.), but some experiments may feature similar drawings.
- Block diagrams illustrating power distribution
- Inhibit diagrams
- Flow diagrams to illustrate data acquisition and handling
- Bonding and grounding diagrams
- Assembly drawings
- Vendor drawings as required to illustrate the configuration and function of unique hardware

4.1.3.2 Parts and Materials Lists

Parts and materials lists identify the specific piece parts, material types, and quantities used in a given assembly. These lists will also contain references to hardware obtained from third parties so that traceability is maintained for procured hardware and software. In the case of Shuttle/ISS programs, the PI is required to provide a parts and materials list as a formal submittal to be approved by the Payload Safety Review Panel. Within the Shuttle/ISS safety organization, these lists are used to ascertain whether out gassing requirements have been met, whether approved suppliers have been used, and in general, whether individual piece parts are acceptable from a safety perspective.

4.1.3.3 Third-Party Hardware and Software

To ensure hardware compliance with drawings and specifications for parts or components procured from third-party organizations, a Certificate of Compliance (CoC) should be obtained for each purchased item. For each CoC, the following information should be included:

- Part number, revision level, and part description. Note: raw materials are considered parts and must be accompanied with a material certification.
- Statement to the effect "the parts supplied are in compliance with all applicable engineering documents"
- Listing of applicable engineering documents, including standards and specifications
- Signature from the supplier's representative

- Applicable dates

Design documentation, including requirements documents, are likely to change throughout the life of the program. The PI should have a method of managing any changes so that 1) the responsible engineering authority approves the changes, and 2) that the formal design documentation reflects these changes. The latter will help ensure that the hardware and software are built as intended.

4.1.3.4 Risk Management

The process of risk management includes identifying and tracking risk areas, developing risk mitigation plans as part of risk handling, monitoring risks, and performing risk assessments to determine how risks change.

Risk management generally occurs at a program level, despite the fact that many of the risk sources are at the subsystem and component levels. For example, STP conducts a formal risk assessment while much of the technical development is the responsibility of Experiment and spacecraft developers. It is unusual for the PI to be in a position to conduct a meaningful risk assessment. However, there are certain activities that tend to mitigate risk and thus contribute to the probability of program success:

- Assigning personnel to the experiment development with the right credentials and performance record
- Identify hardware/software that is immature or is vulnerable to ground or space environments
- Conduct developmental testing or analysis to reduce risk for these items
- Track high-risk items using a watch list and communicate the results with STP
- “Stoplight” charts showing the risk status of each element of the experiment may be useful
- Implement changes in the development strategy to address high-risk items that are not being resolved
- Approach the Shuttle/ISS safety process as a large-scale risk mitigation and mission success exercise, not as a hurdle
- Apply lessons learned from past experiments

4.2 Assembly

4.2.1 Quality of Build / Hardware Integrity

4.2.1.1 Handling

The PI is responsible for identifying critical handling procedures and for communicating these procedures to STP via the ERD or PRD. Special handing procedures, such as critical lifts, application and removal of protective materials, gas purges, etc., should be specified in top-level requirements documents.

The PI should also plan to be present during integration of the experiment with the spacecraft to ensure that handling procedures are being followed. Transport and shipping containers should be designed to minimize damage caused by handling, and any special procedures or notable events that occur during transport shall be recorded in the appropriate certification log.

In some cases, the program will dictate that handling procedures be developed. For example, composite materials are vulnerable to damage that is difficult to inspect, and the program may require the PI develop special handling procedures to protect against latent damage.

4.2.1.2 Electrostatic Discharge (ESD)

The Experiment will be vulnerable to ESD. Procedures must be implemented to prevent ESD damage. ESD damage can go undetected until very late in the program. It may result in an on-orbit failure. Examples of measures that can reduce the potential for ESD damage are:

- ESD-trained personnel
- Facility grounding provisions and a well-defined procedure for maintaining electrical grounding
- Humidity controlled environments
- Use of wrist straps
- Use of grounding tables, particularly for assembling electronics
- A payload design that has a well-defined structural ground

4.2.1.3 Cleanliness

Maintaining cleanliness is a joint responsibility since contaminants can affect not only the Experiment, but also other hardware in the vicinity. For this reason, the PI must transmit via the ERD or PRD specific cleanliness requirements, including facility cleanliness requirements (e.g., Class 100, Class 10000, etc). STP must ensure that PI cleanliness requirements are met during downstream activities, such as integration with the spacecraft. In addition, STP will inform the PI of additional cleanliness requirements imposed by the spacecraft, LV or other experiments.

A number of factors should be considered when planning for a clean environment. Examples are:

- Does the experiment design employ materials that are low-out gassing in a high-temperature, vacuum environment? Note: the mission may have a requirement for low-out gassing materials as measured by percent Collected Volatile Condensable Material (CVCM) and percent Total Mass Loss (TML). Data for various materials can be found in NASA's out gassing database.
- Are facilities equipped to provide the necessary level of cleanliness? For example, Class 100 vs. Class 10000, nitrogen purge capability, etc). What is the established frequency and methodology of particulate measurements/monitoring? What are the consequences of a power failure on the ability to control contamination? Are backup power systems required?
- Are the test fixtures and test equipment compatible with the desired cleanliness? Examples are instrumentation of an experiment prior to entry into a thermal-vacuum chamber and installation and testing on a potentially dirty vibration table
- Are the shipping and handling containers designed to prevent contaminants from affecting the experiment (e.g., vacuum sealed plastic, purging)?
- Are procedures in place to prevent handling-induced contamination (e.g., protective gear, latex gloves, booties, etc.)?
- Are there any special requirements for cleaning the experiment before installation on the spacecraft (e.g., solvents, bakeout, etc.)?

4.2.1.4 Controlled Access

In cases where controlled access is required, the PI should implement the necessary physical security to prevent unauthorized access. A sign-in and escort system should be implemented and a training program established to ensure that access is provided only to personnel who are skilled in the proper treatment of the hardware. Parts destined for use on flight hardware must be stored in locked cabinets to prevent unauthorized access. Additional security requirements on the part of the Experimenter must be coordinated with STP to ensure that these requirements are met during Experiment integration, test, launch, and operations. For experiments that are classified Confidential, Secret, or Top Secret, refer to section 4.4.8.

4.2.1.5 Mandatory Inspection Points (MIPS) and Inspection Reports

At various points during experiment assembly, formal inspections will be conducted to verify the hardware state before continuing. These MIPs are critical steps during assembly, integration, and test of items that must be independently verified in real-time. MIPs generally involve 1) hardware that carries an inherent potential for catastrophic failure 2) hardware that is difficult to inspect after final assembly, and 3) hardware whose assembly is process sensitive.

Inspection reports must be completed as part of the inspection process. Inspections may be documented in a stand-alone report, or within completed procedures or certification logs depending on the scope of the testing. The following information should be included:

- Inspector and qualifications
- Description of inspection, including date of inspection, special procedures, and equipment used.
- Results of inspection, including pass/fail criteria
- Photographs (especially important if the inspected area will be concealed during later stages of assembly)

The results of any inspections should immediately be made known to the responsible engineering authority within the Experiment organization. If an inspection result has an impact beyond the Experiment organization, the PI must notify STP so that appropriate action can be taken.

4.2.2 Assembly Documentation

PIs will have diverse approaches to developing assembly documentation. For spaceflight hardware and software, documentation developed in support of assembly should satisfy the following goals:

- Provide a complete record of the as-built configuration of the hardware and software.
- Provide a complete record of the stages of assembly, including the people, processes, and tools used for assembly.
- Identify variations from the original design, including repairs or deviations (including the necessary approvals).

The level of documentation required to achieve these goals should be coordinated between the PI and STP.

4.2.2.1 Assembly Procedures

Procedures for assembly will either be developed or referenced as part of the design process. During assembly, the PI must adhere to and document established procedures in an Assembly Certification Log or equivalent.

4.2.2.2 Certification Logs

PIs should provide proof that hardware supplied to the program is built according to approved drawings and specifications (materials, processes, etc). For each part manufactured or assembled internally, the PI should maintain certification logs documenting fabrication, Quality Assurance inspections, and subsystem/system level assemblies. In cases where hardware does not comply with applicable drawings and specifications, a formal process for review and approval of the non-compliance should be implemented.

Each certification log shall include the following:

- Part information, including date of manufacture, part number, revision level, part description, lot number, date codes, and serial number.
- Material content of the part, esp. for non-metallic parts. For material content, it is sufficient to refer to the parts list if the parts list contains such information.
- References to drawings and procedure numbers as applicable. All document numbers shall include revision level. Also, include references to the use of trained individuals and related training procedures as applicable.
- Two sets of initials, one each from two individuals who participated in the manufacture and/or inspection of the part and who can confirm that it complies with all applicable engineering data. Initials shall be dated.
- Calibration data for measurement equipment (measuring center of gravity locations, fastener torques).
- Expiration dates of perishable materials (carbon, adhesives, potting compounds, etc.)
- References to mix records for adhesives or compounds that consist of two or more components. Mix records shall contain the following information: component ratios, cure times, and personnel involved in the creation of the adhesive or compound. Note: mix records shall be handled and stored in the same manner as flight hardware.
- References to samples or test coupons used to verify the structural integrity of the flight hardware.
- Record of installation and removal of key components (e.g., locking inserts-number of installs and removals)
- Identification of procedures and chemical agents used to clean flight hardware. Note: this information shall be provided to NASA safety to ensure compatibility with NASA hardware.
- Identification of procedures and materials used to service and maintain the flight hardware (e.g., charging of propulsion systems, pressurization of battery boxes, verification of inhibits, etc). Note: this information shall be provided to NASA safety to support ground operations at KSC.

4.2.2.3 Deviations

Any manufacturing deviations from the intended design must be documented. This includes the following scenarios:

- Errors in manufacturing, flaws or damage that is not within a specified allowable range
- Purposeful hardware changes made on the floor to facilitate assembly

Deviations may be documented in a number of ways, from redlined drawings to formal manufacturing deviation notices. However, any deviations must be reviewed and approved by responsible engineering authorities to verify they will not affect the conduct of the mission. If a deviation has a potential impact beyond the Experiment organization, the PI must notify STP for proper closure.

4.3 Testing

4.3.1 Testing Overview

This overview provides an orientation and roadmap of the typical SV test process and types of tests. Later paragraphs will provide more detailed descriptions of test phases and specific types of testing, descriptions of test documentation, and references to test guidance. The PI will be involved in experiment and spacecraft testing to the extent that:

- Experiment hardware has a significant effect on the overall loading environment (such as thermal or vibration)
- Experiment functional tests are required
- Safety requirements dictate special test requirements for experiment hardware (e.g., composites, mechanisms, optics, etc)
- System level operational testing requires input/interaction from the PI

Testing evaluates space systems and components throughout the design and development process, and may continue on-orbit. Hardware, software, and spacecraft and ground support equipment will be tested through a series of test phases. These phases include development tests, qualification tests, and acceptance tests. Test phases are closely related to the maturity of a program or test article. For example, development testing is conducted early in a program. Therefore, the test article is often at a low level of maturity, but the testing may be conducted at a rigorous level since flight hardware is not involved. In each test phase, the test article may undergo environmental tests, integrated system tests, and compatibility tests.

Testing is performed in accordance with a series of plans that include both an overall test program and specific test plans. A test verification matrix should be used to plan and verify that the system design meets the requirements in the MRD, PIA, or PIP. Test plans should specify data needs, requirements, criteria, evaluation methods, and retest criteria. Each test should be followed by a report of the results. Types of information typically included in a test plan are:

- Test purpose and objectives
- Concept of test operations
- Method(s) of accomplishment
- Test schedules
- Test organization and management
- Personnel responsibilities
- Test configuration and instrumentation
- Data collection and distribution requirements
- Test reports
- Pass/fail/retest criteria

Table 4.3-1 shows different test phases and their normal sequence.

Table 4.3-1: Test Phases

Test Phase	Level	Test Article
Developmental	Any, from Component to Integrated System	Prototype or developmental units
Qualification	Any, from Component to Integrated System	Prototypes or Engineering Test Units
Acceptance	Integrated Systems or Flight level component	Flight Unit

4.3.2 General Phases of Testing

The general phases of testing are developmental, qualification, and acceptance. Each phase is discussed in the following paragraphs.

4.3.2.1 Developmental Testing

Developmental tests are usually conducted early in the design sequence and prove concepts and/or validate test methods to be used for more mature designs. Development tests occur on prototype or development hardware or software to demonstrate feasibility of a concept. From the standpoint of the PI, developmental testing verifies the basic function and establishes performance of specific components or subsystems. The resulting data can be used as a basis for comparison of different design solutions as well as to reduce overall program risk. Developmental testing also provides insight into the test process that may be used in preparation for qualification and acceptance testing. Where practical, development tests should be conducted over a range of operating conditions that exceed the design limits to identify marginal capabilities and marginal design features. Development tests may be conducted on breadboard equipment, prototype hardware, or development and test vehicle equipment.

4.3.2.2 Qualification Testing

Testers conduct qualification tests on flight-like components or systems such as engineering design units. Qualification tests determine the limits of a mature design to ensure that all performance requirements and margins can be met and to reveal any flaws in the design. Results of qualification tests are used to provide final verification of the design before construction of flight hardware.

Qualification testing of flight hardware and software is conducted to demonstrate that the design, manufacturing process, and acceptance program produce mission items that meet specification requirements. In addition, the qualification tests validate the planned acceptance test program, including test techniques, procedures, equipment, instrumentation, and software. Each type of flight item that is to be acceptance tested typically will undergo a corresponding qualification test, except for certain structural items. Such testing should test components, subsystems, and then the complete spacecraft. It should also include functional and environmental testing of selected subassemblies or subsystems. In general, a single qualification test specimen of a given design is exposed to all applicable environmental tests. Multiple qualification test specimens may be required for one-time-use devices (such as explosive ordnance or solid-propellant rocket motors).

A special type of qualification testing is proto-qualification testing. With a proto-qualification strategy, a modified qualification is conducted on a single item and that test item is considered available for flight. Normal acceptance testing is then conducted on all other flight items.

A spacecraft is typically qualified under “first set” conditions or by similarity. First set qualification involves testing the first set of components at qualification levels, then assembling them into the spacecraft and testing the spacecraft at qualification levels. This is known as proto-flight testing. Under similarity, components previously qualified for other applications may be qualified by demonstrating that they will be used in an environment that is essentially identical to that previously qualified.

4.3.2.3 Acceptance Testing

Testers conduct acceptance testing on flight hardware to ensure that the final flight unit meets performance requirements and has no workmanship defects. Because acceptance tests involve flight hardware, they are performed at a less rigorous level than qualification or development tests. However, the acceptance test program should be sufficient to verify performance of the test article in the expected environments using realistic operating scenarios. Testers may tailor test programs depending on the acceptable level of program risk. High-risk programs may combine or eliminate test phases.

Acceptance tests demonstrate the acceptability of each deliverable item. These tests demonstrate conformance to specification requirements and provide quality control assurance against workmanship or material deficiencies. Acceptance testing is intended to stress screen items to produce failures from latent defects in parts, materials, and workmanship. However, the testing should not create conditions that exceed appropriate design safety margins or cause unrealistic failure modes.

For special items, such as some tape recorders and certain batteries, specified acceptance test environments could result in physical deterioration of materials or other damage. In those cases, less severe acceptance test environments that still satisfy system-operating requirements are used.

4.3.3 Specific Types of Testing

A test phase typically includes a number of different tests that make up the SV contractor's system test and evaluation (T&E) program for a particular mission. Test sequences normally include several tests that can be functionally, environmentally, or operationally oriented.

Specific tests considered part of the overall system test process and discussed in following paragraphs include:

- Integrated systems tests (ISTs)
- Environmental tests
- Mass Properties and Envelop Verification
- Compatibility Tests
- "Day in the life" test(s)
- Software Tests.

4.3.3.1 Integrated System Tests (ISTs)

ISTs are system-level functional tests that simulate typical operational scenarios encompassing prelaunch, launch, and on-orbit modes of spacecraft operation. IST verifies the functionality of the integrated SV and experiments. IST results are usually a good measure of how well the integrated SV will meet mission operational requirements. The complete IST may take several days to run on a SV and typically involves subroutines for each subsystem or group of functions.

IST is performed before system environmental testing to establish a performance baseline and readiness for environmental testing. A final IST after environmental testing verifies that performance has not degraded and that the SV is ready for shipment to the launch site. When the SV and LV are first delivered to the launch site, an IST is again conducted as required to assure vehicle readiness for integration. These tests also verify that no changes have occurred in vehicle parameters because of handling and transportation to the launch base.

Most STP system test programs incorporate certain portions, or subroutines, of the ISTs at selected points in the system test flow. These are typically performed between the various system environmental tests and are known as abbreviated ISTs (AISTs). For example, a vibration test may be conducted in three different axes. An AIST may be performed after the test in each axis so that any failures can be tracked to the specific axis. They maintain a known functional performance baseline at every point in the system test flow.

MIL-STD-1540D, MIL-Handbook (HDBK)-340, and DoD-HDBK-343 provide useful technical information for constructing IST plans and procedures.

4.3.3.2 Environmental Tests

Environmental tests are performed to verify that the items under test meet their functional performance requirements under anticipated environmental conditions. Environmental tests performed on a system depend on its characteristics, deployment, and application. Some environmental tests are performed only on qualification hardware. Each program has its own unique environmental test requirements.

Environmental testing generally includes the following tests, some associated with the spacecraft flight environment and others with the on-orbit environment:

- Random vibration test
- Acoustics test
- Shock test
- EMC test
- Pressure/leak test
- Thermal cycle test
- Thermal vacuum test

4.3.3.3 Mass Properties and Envelope Verification:

Once the flight hardware is in its final configuration, tests of mass properties (mass and center of gravity) and final dimensional checks are conducted. These tests verify that payload requirements are satisfied (for the LV). Basic parameters such as mass properties are critical to proper integration and performance of system when mounted in the LV.

4.3.3.4 Compatibility Testing

Compatibility tests validate the compatibility of the SV, the LV, the on-orbit command and control network, and other elements of the space system. Compatibility testing occurs at two different points in the system test process. The first occurrence is a Factory Compatibility Test, which takes place after spacecraft integration, but before environment testing. The second compatibility test, the Launch Base Compatibility Test, takes place after the space vehicle has been delivered to the launch site. A compatibility test demonstrates the ability of the SV and/or LV, when in orbit, to respond to the command and control network hardware, software, and operations teams as expected. To establish compatibility testing baselines, the on-orbit command and control network often is the AFSCN, or interfaces with it. However, there are other command and control networks available to space systems (e.g., commercial X-band networks or dedicated ground stations in some circumstances).

4.3.3.5 Day-in-the-Life Tests

Day-in-the-Life testing focuses on spacecraft operations and verifies that the RSC and integrated space vehicle can meet various mission objectives. This is typically accomplished by performing subsets of mission timeline operations activities. These activities may include any combination of the following:

- Automatic (pre-timed) launch event sequences
- Spacecraft initialization
- Experiment payload initialization
- Nominal on-orbit operations
- Contingency operations and anomaly resolution
- Experiment data processing

These tests are generally conducted in addition to the certified functional tests, IST, and compatibility tests described above.

4.3.3.6 Software Testing

Software development is historically very difficult because of changing user requirements and unique design and coding techniques used by software developers. Rigorous developmental T&E is critical to software systems to allow identification and correction of deficiencies as early in the acquisition process as possible. Software developers should generate test plans, objectives, and procedures early in the acquisition effort. Testers should focus on the user's mission operations requirements and procedures so that they can effectively translate them into valuable test cases and scenarios.

4.3.3.7 DoD and AF Test Directives

The following directives and instructions provide information and guidance for test planning, plans preparation, and test reporting:

- Air Force Policy Directive (AFPD) 99-1, Test and Evaluation Process
- Air Force Instruction (AFI) 99-101, Developmental Test and Evaluation
- AFI 99-102, Operational Test and Evaluation Policy
- Air Force Manual (AFMAN) 99-113, Space Systems Test and Evaluation Process
- Air Force Material Command Policy Directive (AFMCPD) 99-1, Test and Evaluation (T&E) Risk Management
- DOD-HDBK-343, Design, Construction, and Testing Requirements for One of a Kind Space Equipment,
- MIL-HDBK-340A, Test Requirements for Launch, Upper-Stage, and SVs
- MIL-STD-1540D, Product Verification Requirements for Launch, Upper Stage, and SVs

Additionally the Defense Systems Management College Test and Evaluation Management Guide provides guidance on how and when to conduct test and evaluation activities. The guide can be found at: http://www.dau.mil/pubs/pubs-main.asp.

4.4 Mission Operations

Mission operations realize the purpose of the planning and acquisition activities when the experiment is launched, placed into its operational orbit and configuration, and data recovered and processed. However, due to the unique nature of human spaceflight, Shuttle/ISS operations are tailored to each specific payload and mission. Contact STH personnel for specific inquiries on conducting Shuttle/ISS operations. Mission operations consist of training, exercises, and launch rehearsal, launch and early orbit operations, normal and contingency operations, and end of mission activities. Each of these is addressed in the following paragraphs.

4.4.1 Training, Exercises, and Launch Rehearsals

The PI may be required to provide information for, support to generic, and mission specific training for crew operators, staff, and other operations personnel. Training may be informal or on-the-job. The training prepares operations center personnel for exercises and rehearsals that occur before spacecraft launch. This phase of mission operations ends with a successful Operations Readiness Review (ORR).

Exercises are generally events designed to prepare operations center personnel for rehearsals that involve all mission operations personnel, i.e., Mission Director (MD) representatives, spacecraft engineers, and payload scientists. The exercises are intended to provide mission control operators with new mission-specific tools and databases as well as mission timeline flows.

A mission rehearsal program typically consists of a series of rehearsal events that emphasize certain portions of the mission timeline, e.g., Launch and Early Orbit (LEO), spacecraft initialization, etc. Rehearsal focuses on selected activities, e.g., telemetry, tracking, and commanding (TT&C), spacecraft subsystem reconfiguration, and experiment data downlink and processing. As rehearsals are conducted, rehearsal engineers and evaluators assess the performance of crew operators, operational realism, and the effectiveness/benefit of rehearsal scripts and scenarios. Various groups analyze problems and issues encountered during rehearsals for resolution and inclusion in subsequent rehearsals.

The dress rehearsal usually concludes the mission rehearsal program. The dress rehearsal demonstrates that the elements required to perform mission operations effectively (position training, crew interaction, equipment/software tools, databases, procedures, etc.) have sufficiently matured and are ready to be declared "mission ready."

The ORR occurs after dress rehearsal but before the Launch Readiness Review. At the ORR, the operations team presents its declaration of readiness to support launch and on-orbit mission operations. The ORR covers all aspects of the operational organization's readiness to support the mission. The review also addresses Air Force Satellite Control Network (AFSCN) or commercial network readiness to support the mission. Deficiencies in capability for the mission are based on potential mission impact and implementation of solutions.

4.4.2 Launch and Early Orbit Operations (LEO)

LEO starts with the final countdown and ends with SV hand over to the responsible command and control center for daily operations. Several critical actions ensure that the SV is properly configured within the allotted time, that the ground operations center can perform command and control, that sufficient power is maintained on the vehicle, and that critical temperature ranges for designated experiments are not violated. Many STP missions use automatic launch event sequences to control these early SV activities. Activities are generally monitored for timely completion with telemetry gathered from remote ground stations (RGS) that support LEO.

The PI, with other personnel, supports LEO at various locations. STP, the spacecraft contractor, and the PI typically have personnel at both the launch site and the ground operations location to support LEO. Contractor and experiment personnel are required to confirm LV performance and evaluate the health and status of the spacecraft.

On-orbit TT&C of the spacecraft commences upon initial acquisition by a RGS and reception of vehicle telemetry and initiation of commanding by the ground operations location. Depending on the launch location, LV performance, and the actual orbit achieved, first contact with the spacecraft can be anywhere from 15 minutes to an hour or more after launch.

4.4.2.1 On-orbit Spacecraft Initialization

On-orbit spacecraft initialization ensures that the solar arrays are properly deployed, the spacecraft is receiving power, the spacecraft attitude is correct and under positive control authority, and any critical payload turn-on sequences have been accomplished. Successful initialization allows the start of the spacecraft and experiment checkout phase. Initialization begins once the operations personnel have established that the spacecraft is in the planned position and configuration and have taken several passes' worth of telemetry to verify the vehicle's health and status. Initialization typically takes anywhere from days to weeks. Depending on the spacecraft design, much of this process is accomplished under onboard software control. In other cases, the ground operations center may be responsible for commanding all or part of the initialization process.

4.4.2.2 Spacecraft Checkout

Spacecraft checkout verifies proper spacecraft subsystems' performance from the ground operations location by the spacecraft contractor. The task involves the systematic checkout of all on-board systems and subsystems to ensure that the spacecraft is operationally ready for the mission. Successful checkout of the spacecraft allows experiment(s) checkout to begin.

4.4.2.3 Experiment Checkout

Experiment checkout evaluates the experiment payload(s) on the spacecraft. This task is usually led by the PIs for each of the on-board experiments, since they are responsible for experiment performance. A systematic checkout of all on-board experiment systems and functions is performed to ensure that the experiments are operationally ready for the nominal operations phase of the mission. PIs should be present for the entire checkout and verification of their payload.

Depending on the complexity and performance of the experiment(s), number of on-board experiments, and the level of checkout required, this activity might last from a few days to weeks or longer. Successful checkout of the on-board experiments allows the mission objectives to begin.

4.4.2.4 Post Launch Assessment

The STP Office, experimenter PIs, and sponsors meet after each launch to exchange data and experience, offer recommendations, land document lessons learned.

4.4.3 Normal Operations

Normal, on-orbit operations include all TT&C and experiment operations necessary to perform the space test mission. The normal operations phase varies in duration, with some missions being completed in a matter of months while other missions continue for several years. Contact planning, contact operations, and other-than-nominal operations comprise normal operations. Other-than-nominal operations do not imply contingency operations, but may be unplanned experiment science opportunities or new mission objectives. PIs should provide a 24-hour on call point of contact for this operations phase. For some missions, a PI may be required to be physically present during all nominal operations.

On-orbit TT&C contact planning typically consists of the following activities:

- Experiment and spacecraft event inputs
- Creation of experiment and spacecraft uploads
- Integration, formatting, and merging of uploads (as required)
- Coordination/submittal of contact requests to range (includes deconflicting of contact schedules)
- Generation of contact support plans

Normal on-orbit TT&C operations activities typically involve the following:

- Daily and weekly mission planning
- Experiment operations planning
- Spacecraft operations planning
- SV “housekeeping”
- SV health and status evaluation
- Spacecraft and experiment performance trending
- Inter-range resource deconflicting
- Uplink of spacecraft and experiment(s) commands and data
- Downlink of spacecraft telemetry and experiment data

- Processing and distribution of experiment data to users
- Coordination of memoranda (documented changes to mission objectives, operations procedures, data collection requirements, etc.)

Other-than-nominal on-orbit operations may involve the following kinds of activities:

- Contingency operations and anomaly reporting/resolution
- Targets of opportunity (for science observations)
- Changes to mission concept of operations
- Spacecraft Operations

Spacecraft operations comprise those functions that are performed to manage and execute the specific, on-orbit spacecraft activities. These include, but are not limited to, the following:

- Long-term mission planning
- Orbit determination and maintenance
- Rev-to-rev vehicle contact planning and scheduling
- Spacecraft telemetry monitoring (real-time and post pass)
- Spacecraft commanding
- Contingency operations and anomaly resolution

Payload or experiment operations comprise those functions that manage and execute the specific science experiments onboard the orbiting SV. These include, but are not limited to, the following:

- Experiment operations planning
- Experiment configuration management
- Experiment science data evaluation
- Experiment anomaly resolution

4.4.4 Contingency Operations

When problems arise with STP spacecraft or experiments on-orbit, operations personnel typically perform contingency operations procedures. For example, if an event occurs to send a SV into a safe hold mode, there are pre-established contingency procedures used by operators to recover from the situation methodically. Operations personnel may be required to develop or improvise contingency procedures to recover from a given spacecraft situation. PI support from one to several people could be required.

When a contingency situation arises that is not understood and for which there are no pre-established recovery procedures, operations personnel convene an anomaly resolution team. This team, which includes spacecraft contractors, PIs, and Mission Control Team personnel, attempts to understand the current SV status, what caused the anomalous condition(s), and develops a plan to return the SV to normal operations. Once the anomaly is resolved and the SV is returned to nominal operations, an anomaly report is coordinated and closed.

4.4.5 Mission Reports

STP generates various kinds of mission performance reports. One type concerns the degree of success in achieving STP mission objectives. The information is periodically gathered and formatted to report to the Mission Director (MD) how well the experiments are progressing relative to their objectives, how well the spacecraft is supporting experiment operations, and to highlight opportunities to improve mission operations performance. Daily status reports are generated for STP missions to convey the current spacecraft state of health, achieved/failed objectives during the past 24 hours, significant events planned for the next 24 hours, and notes/updates from the last weekly planning meeting.

When on-orbit problems, contingencies, or significant accomplishments occur, STP provides brief reports called “TE Alerts” to SMC leadership and other affected/interested agencies to advise them of the achievement of significant mission milestones or the occurrence of events having potential for mission impact(s). These are released by the MD and are sent to addresses within SMC.

In the event of on-orbit mission loss or degradation, STP submits AF Operational Reporting System reports advising designated higher headquarters of the conditions, timing, and actions related to the event. Procedures for such reporting are described in AFMAN 10-206, Operational Reporting.

4.4.6 Spacecraft and Experiment Data Collection and Reduction

During STP mission operations, mission teams process vast amounts of data. Much of the data are in the form of spacecraft subsystems and onboard experiment telemetry. Other data consist of the actual science data collected and processed by the spacecraft experiments. The ground operations center receives and distributes payload data to the appropriate experiment agencies or the data is directly down linked to designated recipients.

4.4.6.1 Spacecraft Data

During mission operations, spacecraft subsystem engineers (i.e., spacecraft contractors), PIs, and operations center satellite engineers (e.g., RSC satellite engineers) monitor the health and status of the spacecraft to ensure that spacecraft subsystems and the experiments are functioning properly and within prescribed operating limits and constraints. Critical or key telemetry, including orbit ephemeris data, is evaluated real-time on telemetry screens during spacecraft contacts and in quick look reports typically available 15 to 20 minutes after a contact. Larger amounts of telemetry are reviewed more thoroughly “post pass” after the telemetry data have been processed and recorded. Spacecraft engineers and Experiment/PIs use recorded spacecraft telemetry data to perform subsystem analyses (e.g., vehicle orbit/attitude and thermal conditions) and spacecraft subsystems and experiment systems trending (e.g., battery charge levels and experiment cryogenic quantities). Results allow determination and isolation of potential spacecraft problems and facilitate the adjustment or revision of mission plans and objectives.

4.4.6.2 Experiment Data

STP experiment science data or payload data are received in a specific telemetry or data downlink mode and then recorded to data tapes or cartridges. These data, which are usually preprocessed with specific header and command history files, are then packaged and sent to the appropriate experiment agency for full processing and evaluation. PIs periodically generate experiment status reports that give the status of their experiments and the scientific results obtained from their experiment operation. Reports of these results provide important feedback that may affect the planning and scheduling of future mission operations.

4.4.6.3 Archive Requirements

STP missions have data archive requirements for both spacecraft and experiment data. Archive requirements are for both transient data files and permanent records. When the data are archived, certain formats and content are prescribed that ensure ready access, easy identification, and proper processing of the data for specified purposes. The data storage devices are also physically labeled such that data controllers can easily locate certain periods of archived data (e.g., for playback), and the users who receive the data through distribution channels know exactly what portions of data sets they are receiving.

Depending on the experiment, the PI may have to plan, process, and control the mission archives. In some cases, considerable storage capability is required.

4.4.7 End of Mission

When a mission reaches the end of its planned duration, STP executes end of mission and end of life plans. The end of mission plan addresses such issues as contract closeout, final mission assessment and post flight reviews, whereas the end of life plan addresses disposition of the spacecraft such as de-fueling or de-orbiting. The amount of PI support is mission dependent. After a spaceflight, PIs and Sponsors must document results by sending DD Form 1721-2, Space Test Program After Action Report, to the STP Program Office within six months of the completion of the one-year STP mission. For shorter missions such as one-week Shuttle missions, the report is due six months after receiving mission data. As a courtesy, PIs will also provide copies of all papers and reports associated with the experiment to STP for retention in the STP Library. The 1721-2 can be downloaded from http://www.infax.com/webfids/abq/. Instructions for preparation are in Attachment I.

4.4.8 Security

Security is the responsibility of each organization associated with an STP mission. Security policies for the STP missions are derived from National Space Policy as outlined in Executive Order, Presidential Directive, and Secretary of Defense policy. These policies were designed to safeguard the following types of information:

- Detailed quantitative and qualitative information
- Information concerning breakthroughs and significant technical advances in the area of military systems or space application programs until evaluated against related technology
- Technical information that could provide another country with significant assistance with the development of similar equipment, thus reducing the requirement for commensurate expenditure of resources compared to U.S. efforts and reducing the United States lead time advantage
- Information that could significantly assist a potential enemy in the quantitative or qualitative assessment of actual or planned STP-related military or space application

Each experiment should be thoroughly reviewed so that critical aspects listed above are protected. The PI must complete the Experiment Security Questionnaire and submit to STP for review at the same time as DD Form 1721. The PI will be required to provide STP with an export classification of their experiment so that appropriate protection measures can be taken during the integration and safety processes. STP will ensure compliance during the integration and safety process with Security and Export Control guidance provided by the PI.

A program or mission Test Protection Guide/Program Protection Plan (TPG/PPP) establishes a program plan for the safeguarding of classified and unclassified-but-sensitive equipment and information. These guides typically define how contractual security requirements and guidelines are applied to equipment, facilities, and operations information provided by STP mission contractors. They also identify the security and information protection requirements and responsibilities between contractors and other agencies involved in implementing and executing STP missions.

4.4.8.1 Test Protection Guide

TPGs typically extract certain information from the appropriate Security Classification Guides and consolidate it into tailored, mission-specific security guidance for spacecraft procurement, associated ground systems, mission operations and experiment data reduction/dissemination. This information may be consolidated into a security program matrix that cross-references items of information to one another or to organizations/agencies. A level of classification is established for all associations depicted in the matrix. Those items generally noted in such a matrix and thus requiring security consideration include program descriptions, program name designations, Inter-Range Operations Numbers, system functional descriptions, technical references, mission orbits, experiment descriptions, test schedules, launch dates, organizations, and key technical personnel. Facility/Program Security Requirements

4.4.8.2 Program Protection Plan (PPP)

A typical PPP includes the following sections:

- Identification of Program Personnel. Includes Name/Rank, Title, office symbol, and phone of key program personnel.
- Compliance Certification and Approval. States that the program requirements have been reviewed to assure Det 12 compliance with security and protection requirements. Further states that a mission threat and risk analysis, management survey, and security and protection assessment were accomplished as required and results specified within the supplemental PPP. The Det 12 program will implement those policies and guidance outlined within the Det 12 PPP and as supplemented within this document to ensure administrative, managerial and technical program measures remain in force and are operationally adequate to meet security and protection criteria.
- Program Description and System Identification. Discuss and describe the experiment systems and subsystems. Cite communications and interface requirements.
- Objectives of the Experiment. Discuss the mission and objectives of the experiment.
- Management Plans and Project-Unique Procedures.
- Any necessary attachments.
- Security Classification Matrix

STP programs are required to protect appropriately all classified and sensitive material according to the policies and guidelines established in the National Industrial Program Operating Manual (NISPOM). Many directives and guides prescribe certain standards and procedures for carrying out responsibilities under the Defense Industrial Security Program. The following documents are a few of them:

- DoD 5220.22-M, NISPOM, prescribes requirements, restrictions, and other safeguards necessary to prevent unauthorized disclosure of classified information and to control authorized disclosure of classified information released by U.S. Government Executive Branch departments and agencies to their contractors. This document is located at http://www.dss.mil/isec/nispom.htm
- DoD 3500.2, DoD Space Systems Protection Program, implements national security policy and DoD space policy, and requires RDT&E entities to develop protection guides for major systems and support capabilities.
- AF Instruction 31-601, Industrial Security Program Management, which implements AFPD 31-6, Industrial Security Program, provides guidance for implementing the National Industrial Security Program. This instruction is used with the NISPOM, and the Industrial Security Regulation, and DoD 5200.1-R.

4.4.9 Public Affairs

At various times during mission planning, development, and execution, it is appropriate that STP communicate certain mission information to the open press and to civilian organizations. There is no specific formula or detailed checklist as to what information is released or when that information is released. However, there are guidelines for the kinds of information that is useful and/or desired for public release. As to the timing for such information release, it generally occurs when:

- Program/system solicitation is initiated,
- Program/system is officially placed on contract,
- Program/system achieves key milestones in development,
- System's mission is initiated, typically at launch,
- Mission achieves key milestones on-orbit,
- Mission's experiment(s) produce noteworthy scientific information, or
- System's on-orbit mission is terminated.

Outside organizations (such as news organizations) may approach the PI for information pertaining to the various aspects of the mission. Information should only be released according to restrictions identified by the Experiment sponsor as well as any additional restrictions identified in the PI-STP MOA. For example, such restrictions may require the PI to acknowledge STP as a sponsoring organization. Consult STP for specific restrictions regarding your experiment.

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ATTACHMENT A: ACRONYMS

A	
AF	Air Force
AFI	Air Force Instruction
AFMAN	Air Force Manual
AFPD	Air Force Policy Directive
AFSCN	Air Force Satellite Control Network
AIST	Abbreviated Integrated System Test
C	
CDR	Critical Design Review
CoC	Certificate of Compliance
CVCM	Collected Volatile Condensable Material
D	
Det	Detachment
DoD	Department of Defense
E	
EELV	Evolved Expendable Launch Vehicle
ELV	Expendable Launch Vehicle
EMC	Electro Magnetic Compatibility
EMI	Electromagnetic Interoperability
EWG	Experiment Working Group
ERD	Experiment Requirements Document
ESD	Electro Static Discharge
F	
FCP	Fracture Control Plan
H	
HDBK	Handbook
I	
ICD	Interface Control Document
IPT	Integrated Product Team
ISS	International Space Station
IST	Integrated System Test
IURC	Interim User Requirements Collection
J	
JSC	Johnson Space Center
K	
KSC	Kennedy Space Center
L	
LEO	Launch and Early Orbit
LV	Launch Vehicle
M	
MD	Mission Director
MDA	Missile Defense Agency

MIL-STD	Military Standard
MIP	Mandatory Inspection Point
MOA	Memorandum of Agreement
MRD	Mission Requirements Document
MRR	Mission Readiness Review
MSVP	Mechanical Systems Verification Plan
N	
NASA	National Aeronautics and Space Administration
NISPOM	National Industrial Program Operating Manual
NSTS	National Space Transportation System
O	
ORR	Operational Readiness Review
P	
PDR	Preliminary Design Review
PI	Principal Investigator
PIA	Payload Integration Agreement
PRD	Payload Requirements Document
PIP	Payload Integration Plan
PPP	Program Protection Plan
PMRWP	Preliminary Mission Risk White Paper
R	
RDT&E	Research, Development, Test, and Evaluation
R&D	Research and Development
RFP	Request For Proposal
RGS	Remote Ground Station
RSC	RDT&E Support Complex
S	
SAF	Secretary of the Air Force
SERB	Space Experiments Review Board
SFP	Space Flight Plan
SMC	Space and Missile Center
SRR	System Readiness Review
STD	Standard
STH	Shuttle/ISS Payload Missions Directorate of the STP
STP	Space Test Program
ST	Space Test
STS	Mission Development and Execution Directorate of STP
STX	Mission Planning and Design Directorate of STR\P
SV	Space vehicle
SVP	Structures Verification Plan
T	
T&E	Test and Evaluation
TIM	Technical Interchange Meeting
TML	Total Mass Loss
TPG	Test Protection Guide
TRD	Technical Requirements Document

TT&C	Telemetry, Track, and Commanding
U	
USA	Under Secretary for Acquisition
V	
VO	Vehicle Operations VO

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ATTACHMENT B: DEFINITIONS

These definitions are from MIL-HDBK-340A, Volume I. (Variations in some terms as used by STP are noted parenthetically.)

- **Part –** A part is a single piece, or two or more joined pieces, not normally subject to disassembly without destruction or impairment of the design use. Examples include resistors, integrated circuits, or roller bearings.
- **Subassembly** – A subassembly is a unit containing two or more parts that is capable of disassembly without destruction or impairment of the design use. Examples are printed circuit boards with parts installed or gear trains.
- **Unit (Component)** – A unit is a functional item viewed as complete and separate for purposes of manufacturing, maintenance or record keeping. Examples are actuators, valves, batteries, electrical harnesses, or transmitters. (STP typically refers to these items as components.)
- **Subsystem** – A subsystem is an assembly of functionally related components. It consists of two or more components and may include interconnection items such as cables or tubing, and the supporting structure to which they are mounted. Examples are electrical power, attitude control, thermal control, and communications/data handling systems.
- **Spacecraft** – The portion of a space vehicle that carries the space experiment(s) bundled for a specific mission. The spacecraft provides power, communications, and TT&C interfaces to the experiments. The spacecraft is also referred to as the bus.
- **Space Experiment** – A space experiment is usually part of the SV payload and is therefore considered a lower-level assembly of an SV. However, a space experiment may be an integral part of an SV, a payload that performs its mission while attached to an SV, or carried by a host vehicle but performs some of its mission as a free-flyer. (STP often refers to space experiments as payloads integrated on the spacecraft, the latter referred to as the host bus or simply as the bus.)
- **Space Vehicle** – An SV is an integrated set of subsystems and components capable of supporting an operational or test mission in space. An SV may be an orbiting vehicle, a major portion of an orbiting vehicle, or a payload that performs its mission while attached to a launch or upper-stage vehicle. Airborne support equipment, which is peculiar to programs utilizing a recoverable launch or upper-stage vehicle, is considered part of the SV. (STP typically refers to the SV as the space experiment(s) payload plus the host spacecraft bus.)
- **Launch Vehicle** – A launch vehicle is an integrated set of subsystems and components capable of launching and boosting one or more SVs into orbit.
- **System** – A system is a composite of equipment, skills, and techniques and people capable of performing or supporting an operational role or space test mission. A system includes all operational equipment, related facilities, material, software, services, and personnel required for its operation.

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ATTACHMENT C: DD FORM 1721 AND INSTRUCTIONS

This attachment contains a DD Form 1721, and instructions for the required information for each block in the form.

This form can be downloaded from the SAF/USA website at http://www.safus.hq.af.mil/usa/usal/serb/index.htm, or can be obtained in electronic form from STP.

The completed forms must be submitted electronically to dodstp.rideshare@kirtland.af.mil.

SPACE TEST PROGRAM FLIGHT REQUEST	DATE *(YYYYMMDD)*	CLASSIFIED BY	DECLASSIFY ON

PART I - REQUEST FOR SPACEFLIGHT

1. EXPERIMENT TITLE	2. SHORT TITLE/ACRONYM

3. EXPERIMENT NUMBER	4. PROJECT NUMBER	5. PROGRAM ELEMENT NUMBER
6. PROJECT OFFICE	**7. MANAGEMENT OFFICE**	**8. SPONSOR**

9. PRINCIPAL INVESTIGATOR *(REQUIRED)*

a. NAME *(Last, First, Middle Initial)*	b. OFFICE SYMBOL	c. POSITION	d. EMAIL
e. TELEPHONE NUMBER(S) *(Include Area Code)* COMMERCIAL / DSN / PAGER/MOBILE		**f. SIGNATURE**	**g. DATE** *(YYYYMMDD)*

10. PROJECT OFFICE APPROVAL

a. NAME *(Last, First, Middle Initial)*	b. OFFICE SYMBOL	c. POSITION	d. EMAIL
e. TELEPHONE NUMBER(S) *(Include Area Code)* COMMERCIAL / DSN		**f. SIGNATURE**	**g. DATE** *(YYYYMMDD)*

11. MANAGEMENT OFFICE APPROVAL

a. NAME *(Last, First, Middle Initial)*	b. OFFICE SYMBOL	c. POSITION	d. EMAIL
e. TELEPHONE NUMBER(S) *(Include Area Code)* COMMERCIAL / DSN		**f. SIGNATURE**	**g. DATE** *(YYYYMMDD)*

12. SPONSOR APPROVAL *(REQUIRED)*

a. NAME *(Last, First, Middle Initial)*	b. OFFICE SYMBOL	c. POSITION	d. EMAIL
e. TELEPHONE NUMBER(S) *(Include Area Code)* COMMERCIAL / DSN		**f. SIGNATURE**	**g. DATE** *(YYYYMMDD)*

13. INTERMEDIATE ACTIVITY

a. NAME *(Last, First, Middle Initial)*	b. OFFICE SYMBOL	c. POSITION	d. EMAIL
e. TELEPHONE NUMBER(S) *(Include Area Code)* COMMERCIAL / DSN		**f. SIGNATURE**	**g. DATE** *(YYYYMMDD)*

14. DoD DEPARTMENTAL APPROVAL *(REQUIRED)*

a. NAME *(Last, First, Middle Initial)*	b. OFFICE SYMBOL	c. POSITION	d. EMAIL
e. TELEPHONE NUMBER(S) *(Include Area Code)* COMMERCIAL / DSN		**f. SIGNATURE**	**g. DATE** *(YYYYMMDD)*

DATE *(YYYYMMDD)*	**EXPERIMENT TITLE**	**EXPERIMENT NUMBER**

15. REQUESTED STP SERVICES

- ☐ **LAUNCH SERVICES** *(Complete Item 15b)*
- ☐ **LAUNCH INTEGRATION**
- ☐ **SPACECRAFT DEVELOPMENT**
- ☐ **DATA DISTRIBUTION**
- ☐ **OPERATIONS**
- ☐ **SPACECRAFT/EXPERIMENT INTEGRATION**
- ☐ **OTHER** *(Specify):*

a. NUMBER OF FLIGHTS REQUESTED/REQUIRED TO MEET OBJECTIVE:

b. DESIRED FLIGHT MODE *(1=Preferred, 2=Acceptable, Blank=Unacceptable)*

SHUTTLE *(Complete Section IIIA)* **ISS** *(Complete Section IIIA)* **FREEFLYER** *(Complete Section IIIB)* **OTHER** *(Specify):*

16. OBJECTIVE

17. RELEVANCE TO SPECIFIC DOD REQUIREMENTS

18. DESCRIPTION – Please include descriptive website address if applicable.

19. BACKGROUND

DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

20. DESCRIPTIVE GRAPHIC

21. ALTERNATIVES TO SPACEFLIGHT

22. EXPERIMENT UNIQUENESS – Explain how the proposed experiment differs from and/or is complementary to other similar efforts. Indicate if a competition is pending and when award is expected.

23. FOLLOW-ON PLANS

DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

PART II - PROGRAM/SECURITY INFORMATION

24. HARDWARE STATUS

- ☐ FLIGHT READY
- ☐ UNDER CONSTRUCTION
- ☐ BREADBOARD
- ☐ DESIGN
- ☐ CONCEPT

25. DESIGN-FREEZE DATE	26. DELIVERY DATE

27. FUNDING BREAKDOWN *($ Needed / $ Secured)*

a. SOURCE	b. PRIOR FY FUNDS	c. CURRENT FY FUNDS	d. FUTURE FY FUNDS	e. TOTAL COST
	/	/	/	/
	/	/	/	/
	/	/	/	/
	/	/	/	/
	/	/	/	/

f. DATA PROCESSING AND DISSEMINATION FULLY FUNDED? *(Required per AFI-10-1202(I))* ☐ NO ☐ YES

g. ON-ORBIT OPERATIONS BEYOND FIRST YEAR FULLY FUNDED? *(STP only pays for the first year of on-orbit operations per AFI 10-1202(I))*

☐ NO ☐ YES ☐ NOT APPLICABLE

h. REMARKS

28. BUDGET/PROGRAM AUTHORIZATION NUMBER	29. CONTRACTOR RESPONSIBILITY

30. LOCATION OF CONTRACT WORK	31. CONTRACT NO.	32. PLANNED CONTRACT OBLIGATION DATE

33. PLAN FOR DATA PROCESSING AND DISSEMINATION OF RESULTS

34. SECURITY INFORMATION *(State highest levels)*

a. EXPERIMENT OBJECTIVES	b. TIMELINE	c. EXTERNAL VIEW	d. FLIGHT HARDWARE
e. FLIGHT SOFTWARE	**f. EXPERIMENT DATA**	**g. RAW DATA**	**h. INTERNAL FEATURES**

i. IS RAW DATA CLASSIFIED? ***(ISS/Shuttle cannot provide)*** ☐ NO ☐ YES

j. ENCRYPTION OF RAW DATA REQUIRED? ***(ISS/Shuttle cannot provide)*** ☐ NO ☐ YES

k. OTHER CLASSIFIED ITEMS

l. ARE ANY TECHNOLOGIES USED IN THIS EXPERIMENT LISTED IN THE MILITARY CRITICAL TECHNOLOGIES LIST (MCTL) OR THE US MUNITIONS LISTS?

☐ NO ☐ YES

IF YES, ARE THEY CONTROLLED THROUGH THE INTERNATIONAL TRAFFIC IN ARMS REGULATION (ITAR)? ☐ NO ☐ YES

m. ARE FOREIGN NATIONALS INVOLVED WITH THIS EXPERIMENT? ☐ NO ☐ YES

DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

PART IIIA – TECHNICAL DETAILS: SPACE SHUTTLE/ISS

35. FLIGHT OPTIONS

a. SHUTTLE FLIGHT OPTIONS

- ☐ LOCKER
- ☐ SPARTAN
- ☐ CAPE
- ☐ CROSS-BAY
- ☐ OTHER *(Specify)*:

b. ISS FLIGHT OPTIONS

- ☐ EXPRESS PALLET (UNPRESSURIZED)
- ☐ EXPRESS RACK (PRESSURIZED)
- ☐ WINDOW OBSERVATION RACK FACILITY (PRESSURIZED)
- ☐ OTHER *(Specify)*:

36. STANDARD SUPPORT HARDWARE DESIRED

- ☐ LOCKER
- ☐ PAYLOAD EJECTION SYSTEM
- ☐ EXPRESS PALLET ADAPTER PLATE
- ☐ OTHER *(Specify)*:

37. MASS *(kg)*		38. PHYSICAL DIMENSIONS *(cm)*	39. TOTAL VOLUME *(cc)*	40. EXTENSIONS BEYOND PAYLOAD BAY ENVELOPE?
a. TOTAL PAYLOAD	b. EXPENDABLES			☐ NO ☐ YES

41. POWER *(W)*			42. TYPICAL DUTY CYCLE *(% of operation)*		
a. STAND-BY	b. NOMINAL	c. MAX. POWER	a. STAND-BY	b. NOMINAL	c. MAX. POWER

43. MAXIMUM DUTY CYCLE *(% of operation)*			44. MISSION DURATION *(Days)*		
a. STAND-BY	b. NOMINAL	c. MAX. POWER	a. MINIMUM	b. NOMINAL	c. MAXIMUM

45. FLIGHT DATE *(Quarter, Fiscal Year)*			
a. EARLIEST	b. PREFERRED	c. LATEST	d. RATIONALE

46. ORBITAL PARAMETERS

a. NOMINAL SHUTTLE PARAMETERS (193 - 604 km, 28.4 - 57°) ACCEPTABLE? ☐ NO ☐ YES

b. NOMINAL ISS PARAMETERS (370 – 407 km, 51.6°) ACCEPTABLE? ☐ NO ☐ YES

c. DESIRED APOGEE *(km)*	d. DESIRED PERIGEE *(km)*	e. DESIRED INCLINATION *(Degrees)*
+ -	+ -	+ -

f. ALTERNATE ORBITS *(Acceptable, if desired orbit is unavailable)*

g. REMARKS

47. ORIENTATION REQUIREMENTS *(Comment where applicable)*

a. ISS NOMINAL (+/- 15° roll/yaw, -10 to +20° pitch) ACCEPTABLE? ☐ NO ☐ YES

b. X-AXIS	c. Y-AXIS	d. Z-AXIS

e. OTHER REQUIREMENTS

f. VIEWING REQUIREMENTS

- ☐ NADIR
- ☐ ZENITH
- ☐ RAM
- ☐ WAKE
- ☐ WINDOW (NADIR)
- ☐ OTHER *(Specify):*
- ☐ NOT APPLICABLE

g. REMARKS

DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

48. STABILIZATION REQUIREMENTS *(Pointing Accuracy (degrees)/pointing knowledge (degrees/axis))*

a. ISS NOMINAL (control: 3.5 deg/axis/orbit; rate: 0.02 deg/sec/axis; knowledge: 3 deg/axis) ACCEPTABLE? ☐ NO ☐ YES

b. LINE-OF-SITE	c. ROLL ABOUT LINE-OF-SITE	d. JITTER OR DRIFT CONTROL
/	/	/

e. EXPERIMENT PROVIDED POINTER

f. REMARKS

49. MAJOR MOVEMENTS

a. TRACK

b. SLEW

c. OTHER MOTIONS

d. REMARKS

50. ASTRONAUT PARTICIPATION

a. REQUIRED?	b. FUNCTION	c. NON U.S. ASTRONAUT PARTICIPATION ACCEPTABLE?
☐ NO ☐ YES	☐ MONITORING ☐ COMMAND AND CONTROL ☐ ANALYSIS ☐ OTHER *(Specify):*	☐ NO ☐ YES

d. DESCRIPTION OF ASTRONAUT DUTIES

51. GROUND SUPPORT REQUIREMENTS DURING FLIGHT

52. EPHEMERIS REQUIREMENTS

DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

53. TELEMETRY AND DATA HANDLING

a. DATA STORAGE *(Bits per orbit)*	b. DATA OUTPUT RATE *(bps)*		c. COMMAND REQUIREMENTS
			☐ REAL-TIME ☐ NEAR REAL-TIME ☐ NOT REQUIRED

d. SPECIAL REQUIREMENTS

e. REMARKS

54. EXPERIMENT COMPLEMENT/PACKAGE DATA

a. ITEM	b. DIMENSIONS STOWED *(cm)*	c. DIMENSIONS DEPLOYED *(cm)*	d. MASS *(kg)*	e. EJECTED?	f. RECO VERY

g. OTHER PERTINENT DATA

h. DESIGN DRAWING SPECIFICATION STATUS

55. CONTAMINATION CONTROL REQUIREMENTS?

☐ NO ☐ YES *(If yes, explain)*:

56. SPACE SHUTTLE/ISS SAFETY

a. POSSIBLE HAZARDS

RADIOACTIVE DEVICES	☐ NO	☐ YES *(If yes)*: MATERIAL(S):	STRENGTH *(Ci)*:
HAZARDOUS MATERIALS	☐ NO	☐ YES *(If yes)*: MATERIAL(S):	
OTHER	☐ NO	☐ YES *(If yes, specify)*:	

b. DESCRIBE SAFETY COORDINATION ACTIVITIES WITH NASA TO DATE *(If any)*

c. OTHER REQUIREMENTS

DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

PART IIIB - TECHNICAL DETAILS: FREE-FLYER MODE

57. EXPERIMENT CLASS

☐ **EXPERIMENT ONLY** ☐ **COMPLETE SPACECRAFT** ☐ **PIGGYBACK PAYLOAD PREFERRED** *(Specify Host):*

58. MASS *(kg)*			59. PHYSICAL DIMENSIONS *(cm)*
a. TOTAL PAYLOAD	b. EXPENDABLES	c. SPACECRAFT *(If provided)*	

60. TOTAL VOLUME *(cc)*	61. POWER *(W)*			62. TYPICAL DUTY CYCLE *(% of operation)*		
	a. STAND-BY	b. NOMINAL	c. MAX. POWER	a. STAND-BY	b. NOMINAL	c. MAX. POWER

63. MAXIMUM DUTY CYCLE *(% of operation)*			64. MISSION DURATION *(Months)*		
a. STAND-BY	b. NOMINAL	c. MAX. POWER	a. MINIMUM	b. NOMINAL	c. MAXIMUM

65. FLIGHT DATE *(Quarter, Fiscal Year)*		
a. EARLIEST	b. PREFERRED	c. LATEST
d. RATIONALE		

66. ORBITAL PARAMETERS		
a. APOGEE *(km)* + -	b. PERIGEE *(km)* + -	c. INCLINATION *(Degrees)* + -
d. RATIONALE		
e. ALTERNATE ORBITS *(Acceptable, if primary orbit is unavailable)*		
f. AXIS/ORBIT PLANE RESTRICTIONS		

67. STABILIZATION REQUIREMENTS *(Pointing accuracy (degrees)/pointing knowledge (degrees/axis))*		
a. STABILIZATION TYPE ☐ SPIN *(If yes)*: SPIN RATE *(rpm)*: ☐ ANY ☐ 3-AXIS ☐ OTHER *(Specify)*:	b. ROLL / d. YAW	c. PITCH / e. JITTER OR DRIFT
f. OTHER REQUIREMENTS		
g. REMARKS		

DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

68. MAJOR MOVEMENTS *(Explain and provide rates)*

a. TRACK

b. SLEW

c. OTHER MOTIONS

d. REMARKS

69. GROUND SUPPORT REQUIREMENTS DURING FLIGHT

70. EPHEMERIS REQUIREMENTS

71. TELEMETRY & DATA HANDLING

a. DATA STORAGE *(Bits per day)*	b. DATA OUTPUT RATE TO SPACECRAFT *(bps)*		c. REAL-TIME DATA REQUIREMENT *(bps)*
	NOMINAL	MAXIMUM	☐ REAL-TIME DATA NOT REQUIRED ☐ **REAL-TIME DATA REQUIRED AT RATE:**

d. SPECIAL REQUIREMENTS

e. REMARKS

72. COMMANDS

a. NUMBER OF POWER COMMANDS	b. NUMBER OF SERIAL/DIGITAL COMMANDS	
c. NUMBER OF DISCRETE COMMANDS	d. MAGNITUDE COMMAND WORD SIZE *(Bits)*	e. COMMAND STORAGE

f. REAL-TIME COMMAND PROGRAMMING REQUIREMENTS *(Describe)*

DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

73. POSSIBLE HAZARDS

RADIOACTIVE DEVICES	☐ NO	☐ YES *(If yes):* MATERIAL(S):	STRENGTH *(Ci):*
HAZARDOUS MATERIALS	☐ NO	☐ YES (*If yes):* MATERIAL(S):	
OTHER	☐ NO	☐ YES *(If yes, specify):*	

74. CONTAMINATION CONTROL REQUIREMENTS?

☐ NO ☐ YES *(If yes, explain):*

75. EXPERIMENT COMPLEMENT/PACKAGE DATA

a. ITEM	b. DIMENSIONS STOWED *(cm)*	c. DIMENSIONS DEPLOYED *(cm)*	d. MASS *(kg)*

e. OTHER PERTINENT DATA

f. EXPERIMENT EQUIPMENT MOUNTING RESTRICTIONS

g. DESIGN DRAWING SPECIFICATION STATUS

76. OTHER REQUIREMENTS

ADDITIONAL PAGE (If necessary)

NOTE: INDICATE ITEM NUMBER

INSTRUCTIONS FOR COMPLETING

SPACE TEST PROGRAM FLIGHT REQUEST

(DD FORM 1721)

General Information. This DD Form 1721, Space Test Program Flight Request, solicits substantive information needed to evaluate and select experiments proposed for spaceflight and enables STP to accomplish spaceflight planning analyses and payload integration studies prior to recommending assignments of experiments to spaceflights. Some general guidelines for completing this form are as follows:

a. Give actual information, if available, otherwise, use an estimate and so indicate. Provide an acceptable range of performance requirements if feasible to increase the possible number of flight opportunities.

b. Submit a change when information previously submitted changes or when actual information becomes available to replace estimates.

c. If the available space for any item is too small, use additional pages as needed. Although conciseness is desired, considerably more room may be required for specific items in individual cases.

d. It is important that the information on the form details all acceptable flight modes that would be considered. Clearly stating what range of flight modes would be acceptable rather than a single mode increases the flight opportunities for a specific experiment.

e. The form is in several parts. Parts I and II should be completed for all experiments. Part III is divided into separate sections for Shuttle/ISS payloads (Part III-A) and for free-flyer payloads (Part III-B). Fill out the section appropriate to the experiment. If it is desired that the experiment be considered for either means of flight, both Part III-A and Part III-B should be completed.

Security Classification. The entire form will be marked with a security classification commensurate with the highest classification of any single entry. For a classified form, the security classification of each block must be indicated, such as (S) for SECRET. The downgrading block (Classified By:/Declassify On:) must also be completed.

Instructions for Completing Specific Items:

Part I - Request for Spaceflight

Item 1. *Experiment Title.* Select a title that describes the broad objectives of the experiment and uses one or more key words. Nicknames, acronyms, etc., will not be used. The title should be unclassified.

Item 2. *Short Title/Acronym*. Use nicknames and acronyms. The short title/acronym should be unclassified.

Item 3. *Experiment Number*. The acronym of the sponsoring organization followed by four digits consisting of the last two digits of the year and the sponsor's sequential log number in two digits. For example: the first experiment submitted by the Naval Research Laboratory in 2000 would be NRL-0001. Once assigned, this number does not change. Coordination with Service/Agency SERB administrator is necessary.

Item 4. *Project Number*. Give the experiment project number, or the number of the overall project of which the experiment is a part. Realizing that the exact terminology for this numerical identifier varies throughout the DoD, this number reflects the most appropriate sequential sub-breakout below the DoD Program Element Number.

Item 5. *Program Element Number*. Indicate the DoD program element number of the program sponsoring the experiment.

Item 6. *Project Office*. Enter the activity to which the principal investigator responsible for the experiment is assigned.

Item 7. *Management Office*. Enter the activity having management responsibility for the experiment. The Management Office may or may not be the same as the Project Office.

Item 8. *Sponsor*. Enter the agency responsible for the program, project, or task being supported and controlling the resources to develop, fabricate and qualify the experiment.

Item 9. *Principal Investigator*. The individual responsible for the experiment. This individual will be the primary point of contact for the experiment.

Item 10. *Project Office Approval*. The individual to whom the principal investigator reports.

Item 11. *Management Office Approval*. If different from project office approval.

Item 12. *Sponsor Approval*. The individual from the agency responsible for the program, project, or task being supported and controlling the resources to develop, fabricate and qualify the experiment. Responsibilities of the sponsor are outlined in AFI 10-1202(I) paragraph 1.13.

Item 13. *Intermediate Activity*. If applicable.

Item 14. *DoD Departmental Approval***.** The individual with authority to forward spaceflight requests to the Directorate of Space & Nuclear Deterrence, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/USA. See AFI 10-1202(I) paragraph 1.3.

Item 15. *Requested STP Services*. Check all that apply. If requesting launch services, complete 15b.

a. *Number of Flights Requested/Required to Meet Objective*. Indicate the total number of flights that will be requested of STP.

b. *Desired Flight Mode*. Indicate by the notation scheme shown preferred and acceptable flight modes.

Item 16. *Objective*. Describe what is to be accomplished. State the purpose/use of the expected results of the experiment. If there is more than one objective, treat each one separately. If the objective is classified, an unclassified version must be included, if possible.

Item 17. *Relevance to Specific DoD Requirements*. Explain why this experiment should be performed. Emphasize relevance to DOD as much as possible. Indicate potential improvement in military hardware or military operations. Reference current documented military requirements (i.e. document name/number, page number, paragraph title/number). Be prepared to present unclassified documents at SERB.

Item 18. *Description*. Identify and discuss the equipment and the technical approach or technique to be used. State how the experiment objectives are to be obtained. Include descriptive website address if applicable.

Item 19. *Background*. Provide a brief historical summary of the effort. If appropriate, include preliminary investigations in laboratories, ground facilities, aircraft, balloons, space probes, ballistic flights, and spaceflights. References to documents or publications that summarize the history or current status of these efforts are desirable. List each historical flight, the results (i.e., success, failure), and the category of flight experiment (i.e., space probes, balloons, ballistic flights, and spaceflights). How does previous work make the proposed experiment practical? All experiments, not just those of your organization, should be reflected. Update this section as necessary with new developments.

Item 20. *Descriptive Graphic*. Include a descriptive graphic of the experiment.

Item 21. *Alternatives to Spaceflight*. Discuss the need for space test as opposed to ground test and why the experiment requires spaceflight.

Item 22. *Experiment Uniqueness*. Explain how the proposed experiment differs from and/or is complementary to other similar efforts. Indicate if a competition is pending and when award is expected.

Item 23. *Follow-on Plans*. Discuss the next step if this experiment is flown and if additional spaceflights are needed/anticipated.

Part III - Program/Security Information

Item 24. *Hardware Status*. Self-explanatory.

Item 25. *Design-Freeze Date*. Indicate when the design has or will be frozen. This normally occurs when detail drawings are released for hardware fabrication.

Item 26. *Delivery Date*. Indicate when hardware could be delivered for integration onto the spacecraft or launch vehicle system. This can be given in terms of months after flight assignment.

Item 27. (a-e) *Funding Breakdown*. Indicate funds previously obtained or expended to date, funds planned for the current fiscal year, and funds needed for future fiscal years. Distinguish between funds that are needed and those that have been secured. Total cost includes all costs supported by the experiment sponsor and all other agencies, businesses, etc., supporting this effort. Do not include the cost of STP requested services.

f. *Data Processing and Dissemination Fully Funded?* Required per AFI 10-1202(I) paragraph 1.4.

g. *On-orbit Operations Beyond First Year Fully Funded?* Self-explanatory.

h. *Remarks.* Include additional remarks concerning funding status.

Item 28. *Budget/Program Authorization Number.* Give the budget and program authorization numbers approving the expenditure of funds for the experiment by the sponsoring agency or higher authority.

Item 29. *Contractor Responsibility*. Provide the name of the primary contractors and briefly indicate their responsibilities.

Item 30. *Location of Contract Work*. Give the location of the hardware, if already fabricated, or the design/manufacturing effort.

Item 31. *Contract Number*. Self-explanatory.

Item 32. *Planned Contract Obligation Date*. Indicate when contracts were or are planned to be obligated.

Item 33. *Plan for Data Processing & Dissemination of Results*. Describe how the data will be processed and results disseminated to potential users. Specifically, what project or person will use your data?

Item 34. (a-h) *Security Information*. Designate items a through h with the highest security applicable to this experiment by U (for UNCLASSIFIED), C (for CONFIDENTIAL), S (for SECRET), or TS (for TOP SECRET).

i. *Is Raw Data Classified?* Self-explanatory. Note: A Shuttle/ISS flight cannot accommodate a request for classified raw data.

j. *Encryption of Raw Data Required?* Self-explanatory. Note: A Shuttle/ISS flight cannot accommodate a request for raw data encryption.

k. *Other Classified Items.* Identify other classified elements of the experiment and show their classification.

l. *Are Any Technologies Used in This Experiment Listed in the Military Critical Technologies List (MCTL) or the US Munitions Lists? If Yes, Are They Controlled Through the International Traffic in Arms Regulation (ITAR)?* Self-explanatory.

m. *Are Foreign Nationals Involved With This Experiment?* Self-explanatory.

Part III-A. Technical Details: Space Shuttle/ISS

Complete this section only if the experiment is to be considered for a Shuttle/ISS flight mode.

Item 35. *Flight Options.*

a. *Shuttle Flight Options.* Check all that apply.

b. *ISS Flight Options.* Check all that apply.

Item 36. *Standard Support Hardware Desired.* Check all that apply.

Item 37. (a-b) *Mass*. Provide the current best estimate of total experiment mass and expendable mass in kilograms. Expendables include items that will be ejected from the Shuttle and/or consumed in the conduct of the experiment.

Item 38. *Physical Dimensions*. List the actual physical dimensions of the hardware, (i.e., the compact shape not to include large or prominent voids--indicate, however, any appendages such as booms, antennas, etc.). State all dimensions in centimeters.

Item 39. *Total Volume*. Estimate the total volume of the experimental hardware in cubic centimeters.

Item 40. *Extensions Beyond Bay Envelope?* If any portion of the experiment (excluding ejectables) extends outside the dynamic envelope of the Shuttle bay when fully deployed, check yes.

Item 41. (a-c) *Power*. Indicate stand-by, nominal and maximum power in watts. All entries should denote only the power that is to be provided to the experiment by the support equipment.

Item 42. (a-c) *Typical Duty Cycle*. Enter the typical or nominal percentage of one day's operation for each of the power levels in Item 41.

Item 43. (a-c) *Maximum Duty Cycle*. Consider also a realistic maximum (most stressing) duty cycle.

Item 44. (a-c) *Mission Duration*. Express the mission duration requirements in days. Exclude from consideration time for ascent, descent, or deployment of host payload. Minimum refers to the shortest time that could successfully meet the stated objectives. Nominal denotes a typical mission. Maximum may be dictated by battery life or other considerations; if there is no maximum, leave this item blank.

Item 45. (a-c) *Flight Date*. Indicate the quarter and fiscal year of the earliest, preferred and latest desired/required date for flight. If no latest date can be provided at this time, write open. The earliest date should be estimated based on the experiment delivery date, allowing a reasonable length of time for experiment integration.

d. *Rationale.* Explain the rationale for the dates given in a-c.

Item 46. *Orbital Parameters*.

a. *Nominal Shuttle Parameters Acceptable?* Self-explanatory.

b. *Nominal ISS Parameters Acceptable?* Self-explanatory.

c. *Desired Apogee.* Indicate the apogee in kilometers, including tolerances, required to meet the stated objectives.

d. *Desired Perigee.* Indicate the perigee in kilometers, including tolerances, required to meet the stated objectives.

e. *Desired Inclination.* Indicate the inclination in degrees, including tolerances, required to meet the stated objectives.

f. *Alternate Orbits.* Indicate acceptable alternative orbits if the orbits indicated in c-e are not available.

g. *Remarks.* Indicate additional orbital requirements.

Item 47. *Orientation Requirements*.

a. *ISS Nominal Acceptable?* Self-explanatory.

b. *X-Axis.* Indicate X-Axis orientation requirements.

c. *Y-Axis.* Indicate Y-Axis orientation requirements.

d. *Z-Axis.* Indicate Z-Axis orientation requirements.

e. *Other Requirements.* Indicate any additional orientation requirements necessary to perform the experiment.

f. *Viewing Requirements.* Self-explanatory.

g. *Remarks.* Indicate any additional orientation requirements or concerns.

Item 48. *Stabilization Requirements*.

a. *ISS Nominal Acceptable?* Self-explanatory.

b. *Line-of-Site.* Provide experiment pointing accuracy and pointing knowledge requirements for line-of-sight.

c. *Roll About Line-of-Site.* Provide experiment pointing accuracy and pointing knowledge requirements for roll about line-of-sight.

d. *Jitter or Drift Control.* Indicate jitter or drift control requirements, if applicable.

e. *Experiment Provided Pointer.* If the experiment is to be mounted on an experiment-provided pointer, specifications on pointing, jitter or drift are not to be provided.

Item 49. (a-d) *Major Movements*. Discuss track or slew requirements. Include under "other motions" requirements for instrumented booms, masts, RMS, or special field-of-view envelopes.

Item 50. *Astronaut Participation.*

a. *Required?* Self-explanatory.

b. *Function.* Check the functions an astronaut will be expected to perform.

c. *Non US Astronaut Participation Acceptable?* Self-explanatory.

d. *Description of Astronaut Duties.* Summarize briefly the major tasks for the astronaut noting essential and desired functions.

Item 51. *Ground Support Requirements During Flight.* Describe any coordinated ground support activities that will occur during the flight.

Item 52. *Ephemeris Requirements*. Provide accuracy requirements in terms of a root sum square error or crosstrack, in-track, and radial errors; also indicate update requirements, if known. Indicate if the requirement is for real-time knowledge or post-flight data.

Item 53. (a-e) *Telemetry And Data Handling*. Make a best estimate of telemetry requirements. Acceptable delay times for ground reception should be indicated. Real-time downlink should be minimized to the extent possible.

Item 54. (a-h) *Experiment Complement/Package Data*. Provide a breakdown of the experiment into subassemblies based on packaging or modules, and/or in terms of separate experiments constituting the total experiment. Provide stowed and deployed (as applicable) dimensions in centimeters. The mass is to be provided in kilograms, and total mass for all items must agree with Item 37. Indicate the status of the final design drawings. Note the timetable of any critical specifications that are not presently determined.

Item 55. *Contamination Control Requirements.* Self-explanatory.

Item 56. (a-c) *Space Shuttle/ISS Safety*. Indicate any radioactive or hazardous materials and other safety considerations. Describe the status of any safety coordination activities already undertaken with NASA. Note desirable correlative experiments (specific experiments or experiment classes) and unique temperature or thermal load requirements. Also, indicate any special requirements such as keeping the instrument in a clean-room facility and of what class. Additionally, indicate any special requirements during integration and testing, e.g., instrument purging and health monitoring, removal of instrument after integration testing for preflight calibration.

Part III-B - Technical Details: Free-Flyer Mode

Complete this section only if the experiment is to be considered for flight on a free-flying satellite.

Item 57. *Experiment Class*. Check one of the following categories as follows:

<u>Experiment Only</u> - the experiment consists of one or more items requiring support from a spacecraft not provided as a part of the experiment.

<u>Complete Spacecraft</u> - the experiment is to be supplied to STP as a self-contained spacecraft.

<u>Piggyback Payload</u> - the experiment is specifically designed as a piggyback payload for a specific spacecraft host.

Item 58. (a-c) *Mass*. Provide the current best estimate of the total experiment mass and expendable mass in kilograms. "Expendables" include items that will be ejected from the spacecraft and/or consumed in the conduct of the experiment.

Item 59. *Physical Dimensions*. List the actual physical dimensions of the hardware (i.e., the compact shape not to include large or prominent voids--indicate, however, any appendages such as booms, antennas, etc.). State all dimensions in centimeters.

Item 60. *Total Volume*. Estimate the total volume of the experimental hardware in cubic centimeters.

Item 61. (a-c) *Power*. Indicate stand-by, nominal and maximum power in watts. All entries should denote only the power that is to be provided to the experiment by the support equipment.

Item 62. (a-c) *Typical Duty Cycle*. Enter the typical or nominal percentage of one day's operation for each of the power levels in Item 61.

Item 63. (a-c) *Maximum Duty Cycle*. Consider also a realistic maximum (most stressing) duty cycle.

Item 64. (a-c) *Mission Duration*. Express the mission duration requirements in months. "Nominal" denotes a typical mission. "Minimum" refers to the shortest time that could yield a successful experiment. "Maximum" might be dictated by battery life or other considerations. If there is no maximum, leave this item blank.

Item 65. (a-d) *Flight Date*. Indicate the quarter and fiscal year of the preferred and latest desired/required date for flight. If no latest date can be provided at this time, write, "open." The earliest date should be estimated based on the experiment delivery date, allowing a reasonable length of time for experiment integration.

Item 66. *Orbital Parameters*.

a. *Apogee.* Indicate the apogee in kilometers, including tolerances, required to meet the stated objectives.

b. *Perigee.* Indicate the perigee in kilometers, including tolerances, required to meet the stated objectives.

c. *Inclination.* Indicate the inclination in degrees, including tolerances, required to meet the stated objectives.

d. *Rationale.* Indicate the rationale for the parameters given in a-c.

e. *Alternate Orbits.* Indicate acceptable alternative orbits if the orbit indicated in a-c is not available.

f. *Axis/Orbit Plane Restrictions.* Indicate additional orbital requirement/restrictions, if applicable.

Item 67. (a-g) *Stabilization Requirements*. Indicate type of vehicle stabilization required, if any. Provide experiment pointing accuracy and pointing knowledge. If special jitter or drift requirements are given, control duration should also be provided. If the experiment is to be mounted on an experiment-provided pointer, specifications on pointing, jitter or drift are not to be provided.

Item 68. (a-d) *Major Movements*. Discuss track or slew requirements. Include under "other motions" requirements for instrumented booms, masts, or special field-of-view envelopes.

Item 69. *Ground Support Requirements During Flight*. Describe any coordinated ground support activities that will occur during the flight.

Item 70. *Ephemeris Requirements*. Provide accuracy requirements in terms of a root sum square error or crosstrack, in-track, and radial errors; also indicate update requirements, if known.

Item 71. (a-e) *Telemetry and Data Handling*. Estimate the maximum amount of data to be taken on a typical orbit. Estimate the rates at which the spacecraft will be required to record the data. Make a best estimate of telemetry requirements. Acceptable delay times for ground reception should be indicated. Real-time downlink should be minimized to the extent possible.

Item 72. (a-f) *Commands*. Estimate requirements for the different types of commands. "Power on" and "Power off" for an item are considered separate commands. If it is determined that command storage is required, so indicate.

Item 73. *Possible Hazards*. Indicate any radioactive, hazardous materials or other safety considerations.

Item 74. *Contamination Control Requirements?* Self-explanatory.

Item 75. (a-g) *Experiment Complement/Package Data*. Provide a breakdown of the experiment into subassemblies, based on packaging or modules, and/or in terms of separate experiments constituting the total experiment. Provide stowed and deployed (as applicable) dimensions in centimeters. Provide mass in kilograms; the total mass for all items must agree with Item 58. Indicate the status of the final design drawings.

Item 76. *Other Requirements*. Provide any other information necessary to allow STP to meet the experiment requirements. Indicate here items not considered earlier. Note desirable correlative experiments (specific experiments or experiment classes) and unique temperature or thermal load requirements. Indicate specific launch-window requirements, if any. Also, indicate any special requirements such as keeping the instrument in a clean-room facility and of what class. Additionally, indicate any special requirements during integration and testing, e.g., instrument purging and health monitoring, removal of instrument after integration and testing for preflight calibration, etc.

ATTACHMENT D: DD FORM 1721-1 AND INSTRUCTIONS

This attachment has a copy of the blank form and the instructions for completing the blocks for the DD Form 1721-1.

This form can be downloaded from the SAF/USA website at http://www.safus.hq.af.mil/usa/usal/serb/index.htm, or can be obtained in electronic form from STP.

SPACE TEST PROGRAM
FLIGHT REQUEST EXECUTIVE SUMMARY

CLASSIFY BY

DECLASSIFY ON

1. EXPERIMENT TITLE

2. SHORT TITLE/ACRONYM

3. EXPERIMENT NUMBER

4. DATE *(YYYYMMDD)*

5. OBJECTIVE

6. DESCRIPTION – Please include descriptive website address if applicable

7. RELEVANCE TO SPECIFIC DOD REQUIREMENTS

8. REQUIREMENTS SUMMARY

a. REQUESTED STP SERVICES

☐ LAUNCH SERVICES
☐ LAUNCH INTEGRATION
☐ SPACECRAFT DEVELOPMENT
☐ DATA DISTRIBUTION
☐ OPERATIONS
☐ SPACECRAFT/EXPERIMENT INTEGRATION
☐ OTHER *(Specify):*

b. NUMBER OF FLIGHTS REQUESTED/REQUIRED TO MEET OBJECTIVES

c. FLIGHT DURATION REQUIRED

d. FLIGHT MODE *(1=Preferred, 2=Acceptable, Blank=Unacceptable)*

FREE-FLYER SHUTTLE ISS OTHER *(Specify)*

e. POWER *(W)*

STAND-BY NOMINAL MAXIMUM

f. DIMENSIONS *(cm)*
X X

g. MASS *(kg)*

h. VOLUME *(cc)*

i. HARDWARE FLIGHT READY DATE *(YYYYMMDD)*

j. STABILIZATION TYPE

k. ORBIT REQUIREMENTS *(km)*
APOGEE + -
PERIGEE + -

l. INCLINATION *(Degrees)*
\+ -

m. OTHER REQUIREMENTS

9. PROGRAM SUMMARY

a. FUNDING BREAKDOWN *($ Needed/$ Secured)*

a. SOURCE	PR. B	CURRENT FY FUNDS	FUTURE FY FUNDS	TOTAL COST
	/	/	/	/
	/	/	/	/
	/	/	/	/

b. DESIGN/FABRICATION STATUS

c. CONTRACTOR

10. DoD DEPARTMENTAL APPROVAL

a. APPROVING OFFICIAL *(Last Name, First, Middle Initial)*

b. OFFICE SYMBOL

c. POSITION

d. MAILING ADDRESS *(Street, Apt/Suite No., City, State, ZIP Code)*

e. TELEPHONE NUMBER(S) *(Include Area Code)*
COMMERCIAL DSN

f. SIGNATURE

g. EMAIL

h. PRINCIPAL INVESTIGATOR *(Last Name, First, Middle Initial)*

i. OFFICE SYMBOL

j. POSITION

k. MAILING ADDRESS *(Street, Apt/Suite No., City, State, ZIP Code)*

l. TELEPHONE NUMBER(S) *(Include Area Code)*
COMMERCIAL DSN

m. SIGNATURE

n. EMAIL

INSTRUCTIONS FOR COMPLETING

SPACE TEST PROGRAM FLIGHT REQUEST - EXECUTIVE SUMMARY

(DD FORM 1721-1)

General Information. The Space Test Program Flight Request **-** Executive Summary requests information required by management for "quick look" understanding and evaluation for a proposed flight experiment. The Executive Summary will describe the objective(s) of the experiment and military value or relevance. It will also provide a summary of flight specifications and requirements, funding and hardware status.

Security Classification. The form will be marked with a security classification commensurate with the highest classification of any single entry on the page. For a classified form, the security classification of each block must be indicated such as (S) for SECRET. The downgrading block (Classified by:/Declassify On:) must also be completed.

Instructions for Completing Specific Items:

Item 1. *Experiment Title*. Select a title that describes the broad objectives of the experiment and uses one or more key words. Nicknames, acronyms, etc., should not be used. The title should be unclassified.

Item 2. *Short Title/Acronym*. Use nicknames and acronyms. The short title/acronym should be unclassified.

Item 3. *Experiment Number*. The acronym of the sponsoring organization followed by four digits consisting of the last two digits of the year and the sponsor's sequential log number in two digits. For example: the first experiment submitted by the Naval Research Laboratory in 2000 would be NRL-0001. Once assigned, this number does not change. Coordination with Service/Agency SERB administrator is necessary.

Item 4. *Date*. Self-explanatory.

Item 5. *Objective*. Describe what is to be accomplished. State the purpose/use of the expected results of the experiment. If there is more than one objective, treat each one separately. If the objective is classified, an unclassified version must be included, if possible.

Item 6. *Description*. Identify and discuss the equipment and the technical approach or technique to be used. State how the experiment objectives are to be obtained. Include descriptive website address if applicable.

Item 7. *Relevance to Specific DoD Requirements*. Explain why this experiment should be performed. Emphasize relevance to DoD as much as possible. Indicate potential improvement in military hardware or military operations. Reference current documented military requirements (i.e. document name/number, page number, paragraph title/number). Be prepared to present unclassified documents at SERB.

Item 8. *Requirements Summary*.

a. *Requested STP services*. Check all that apply.

a. *Number of Flights Requested/Required to Meet Objectives*. Indicate the total number of flights that will be requested of STP.
b. *Flight Duration Required*. Indicate flight duration required to meet the stated objectives.
c. *Flight Mode*. Indicate by the notation scheme shown preferred and acceptable flight modes.
d. *Power*. Indicate stand-by, nominal and maximum power in watts.
e. *Dimensions*. Indicate the dimensions of the experiment in centimeters.
f. *Mass*. Indicate the mass of the experiment in kilograms.
g. *Volume*. Indicate the volume of the experiment in cubic centimeters.
h. *Hardware Flight Ready Date*. Indicate the date on which the experiment could be delivered for integration with the spacecraft or support equipment.
i. *Stabilization Type*. Indicate the type of stabilization required, if applicable.
j. *Orbit Requirements*. Indicate the apogee and perigee in kilometers, including tolerances, required to meet the stated objectives.
k. *Inclination*. Indicate the inclination in degrees, including tolerances, required to meet the stated objectives.
l. *Other Requirements*. Indicate any additional requirements necessary to meet the stated objectives.

Item 9. *Program Summary*.

a. *Funding Breakdown*. Indicate funds previously obtained or expended to date, funds planned for the current fiscal year, and funds needed for future fiscal years. Distinguish between funds that are needed and those that have been secured. Total cost includes all costs supported by the experiment sponsor and all other agencies, businesses, etc., supporting this effort. Do not include the cost of STP requested services.

a. *Design/Fabrication Status*. Indicate the current status of the experiment.
b. *Contractor*. Indicate the experiment contractor, if applicable.

Item 10. *DoD Departmental Approval*.

a-g. *Approving Official*. The individual with authority to forward spaceflight requests to the Directorate of Space & Nuclear Deterrence, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/USA). See AFI 10-1202(I), paragraph 1.3.

h-n. *Principal Investigator*. The individual responsible for the experiment. This individual will be the primary point of contact for the experiment.

ATTACHMENT E: SPACE EXPERIMENT REVIEW BOARD BRIEFING TEMPLATE

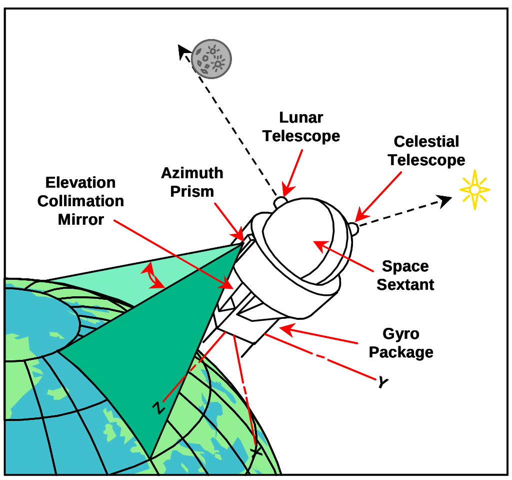
Sample SERB briefing slides are shown below. The five slides represent the minimum number of slides to adequately brief an experiment at a SERB. More slides may be required to brief unique requirements of particular experiment or mission. Additional experiment subsystem or operations slides may be placed in the briefing as backups, to be briefed as necessary.

This example can be downloaded from the SAF/USA website at http://www.safus.hq.af.mil/usa/usal/serb/index.htm, or can be obtained in electronic form from STP.

EXAMPLE

ABCD-0012 - Autonomous Navigation and Attitude Reference System (ANARS)

Concept



Descriptive Graphic

Objective: Investigate the use of an onboard autonomous spacecraft navigation capability.

- Independent of ground control
- Sustain approximate orbital accuracy of ±800 ft
- Emergency back-up operation for primary ground station failure due to catastrophic or hostile action

Description: Observes stars and lunar limb offset angles from nadir reference gyro by means of space sextant. Earth azimuth and elevation are optically referenced.

Equipment:

•Lunar telescope	•Gyro package
•Celestial star telescope	•Elevation collimation mirror
•Azimuth prism	•Space Sextant

EXAMPLE

ABCD-0012 - Autonomous Navigation and Attitude Reference System (ANARS)

Justification

- **Military Relevance**
  - AFSPC MNS 003-91, pg 3-4, paragraph 3.3.2, Spacecraft Navigation
  - Supports operational requirements for NPOESS, SBIRS
  - Addresses satellite navigation deficiency identified in AFSPC MAP's
  - Potential applications to existing operational systems such as AWS, DMSP, Future communication systems
  - Technology base new initiative for "Survivable Satellite" ACTD #123
- **Need for Spaceflight**
  - Test for accuracy not achievable on the ground
  - Tracking rates unrealistic if tried from ground/air
  - Required for risk-reduction prior to deployment of first SBIRS in FY03
- **Comparison to Alternatives**
  - ANARS ±800 ft and 1 arc sec pointing accuracy
  - GPS more accurate (± 10 ft) but does not provide autonomy
  - NASA's SANS program not fully autonomous, less accurate

EXAMPLE

ABCD-0012 - Autonomous Navigation and Attitude Reference System (ANARS)

Detailed Overview

- **Flight Data:**
  - Free-flyer: 900 (± 50) km, Circular orbit, >90° Inclination
  - 1 flight required (12 months duration) to meet objectives
  - 1.5 m^3, 182 kg, nominal 250 W
- **Status:**
  - Hardware fabricated; modifications required to gyro package and elevation collimation mirror
  - CDR Complete July 2000
  - Flight Ready 4Q FY 02
- **Priority:**
  - 2000 AF SERB 2/26
  - 1999 DoD SERB 5/40
- **Requested STP Services**
  - ✓ Launch Services
  - ✓ Launch Integration
  - ✓ Spacecraft Development
  - ✓ Operations
  - ✓ Spacecraft/Experiment Integration
  - ✓ Data Distribution
- **Experiment Funding:**
  - Total Cost: $18.7M
  - No out of budget requests/requirements
  - Experiment 90% funded through completion

	Prior	FY00	FY01	FY02	FY03
Req't	$2.4M	$3.1M	$7.2M	$5.4M	$0.6M
Actual	$2.4M	$3.1M	$6.5M	$4.8M	0

EXAMPLE

ABCD-0012 - Autonomous Navigation and Attitude Reference System (ANARS)

Summary of Data Application

- The Air Force Research Lab's Space Vehicles Branch and DARPA will utilize the data from this experiment to develop a guidance system which allows two satellites to effect an orbital rendezvous without human input
- This data will ultimately enable formations of satellites to autonomously transfer from a communication mission configuration to a reconnaissance mission configuration
- The data analysis will be complete 18 months after the experiment is launched
- Applicable category of this research is Applied Research

EXAMPLE

ABCD-0012 -Autonomous Navigation and Attitude Reference System (ANARS)

Flight Mode Suitability

Flight Mode	% Experiment Objectives Satisfied
Shuttle	0%
Shuttle Deployable	15%
Shuttle Deployable with Propulsion	40%
International Space Station	25%
"Piggyback" Free-flyer on ELV	80%
Dedicated Free-flyer on ELV	100%

How important is it to retrieve your flight hardware for analysis or reflight? Can you place a dollar value on this? What is it?

Not necessary for this experiment.

INSTRUCTIONS FOR DoD SERB EXPERIMENT PRESENTATIONS

Experiment Rating Criteria: The SERB will rate presented experiments according to:

Military Relevance - 60%
Quality of Experiment - 20%
Service Priority - 20%

Security: Presentations may be classified up to the SECRET classification. All charts and computer disks must be marked accordingly. Receipt and storage of classified material will be available at the SERB. All presentations will be given in a secured room, and the clearances of all attendees will be verified prior to classified briefings. Unclassified charts are highly preferable, even if the verbal presentation contains classified material.

Briefing Content: To help ensure the proper information is available to the SERB, and briefing time limitations are observed, **each presentation must include the following five charts as a minimum**. The information outlined below must be contained on five charts, requiring careful selection of the necessary information. **These five charts must be the first five charts briefed**. Additional charts may be presented only after the required five have been briefed, and only if there is remaining time in the 15-minute limit. Sample charts are included to illustrate the type of information that must be provided as well as the required format. Each chart should be clearly labeled with the experiment title, short title and experiment number.

Chart 1 Chart Title: **CONCEPT**

Chart Content

- Experiment objective
- Experiment description (including detailed performance parameters, measurement accuracy and sensor specification, etc.)
- Descriptive graphic of the experiment

Chart 2 Chart Title: **JUSTIFICATION**

Chart Content:

- Military relevance (Reference US Space Command's Long Range Plan, http://www.spacecom.mil/LRP/LRP-FactSheet.htm, and cite specific needs of military agencies. Include specific references to documented military requirements, i.e. document name/number, page number, paragraph title/number.)
  - Relevance to existing operational programs
  - Relevance to programs in engineering and development phase
  - Relevance to high priority R&D initiatives (ACTDs)
- Justification for spaceflight (discuss the need for space test as opposed to ground test and why the experiment requires spaceflight)

- Comparison to alternatives, collateral or complementary technology experiments (both inside and outside of DoD)

Chart 3 Chart Title: **DETAILED OVERVIEW**

Chart Content:

- Flight data (orbit requirements, size, mass, power requirements, number of flights requested, mission duration, and any other specific needs or details)
- Status (include hardware completion date and current experiment status)
- Priority (address current and past year Service and DoD SERB rankings)
- Requested STP Services (Include one or more of the following: launch services, launch integration, spacecraft development, data distribution, operations, spacecraft/experiment integration)
- Funding (Identify total cost, funding requirement by fiscal year, and actual funded amounts by fiscal year) – **NOTE** – Not to include funds associated with requested STP services.

Chart 4 Chart Title: **SUMMARY OF DATA APPLICATION**

This chart is intended to summarize the intended application(s) of the data gained from the spaceflight of the experiment. The example chart should be used as a template, and customized as needed. You may replace the underlined text with your own (or customize the wording, if necessary) as long as the four bullets below are addressed.

Chart Content:
The first bullet should specifically identify what system or model will use the data from this experiment, and by which organization(s).
The second bullet specifies how the warfighter or national decision maker will use the eventual system or model to be more effective.
The third bullet specifies when the reduced experiment data will be available.
The last bullet defines the category of the research as Basic Research, Applied Research, or Advanced Technology Demonstration.

Chart 5 Chart Title: **FLIGHT MODE SUITABILITY**

With the expansion of some Shuttle/ISS capabilities and the addition of the International Space Station as an option for flying SERB experiments, STP now has a wide range of flight modes available for SERB experiments. Each of these modes has both advantages and disadvantages. Therefore, it has become important for the PI to provide additional guidance on the value of the various flight modes.

The information contained on this chart will enable STP to better consider trades involving priority, cost, time to flight, and percentage of objectives accomplished. Obviously, priority and available funding play a key role in the ability to fly via any of the modes.

Chart Content:

- An estimate of the percentage of experiment objectives that can be accomplished via each of the defined flight modes
- Need for flight hardware retrieval and associated cost savings
- Capabilities and constraints for each flight mode are included below:

Definitions of Flight Modes:

Shuttle

- 28 to 57° inclination
- 300 to 460 km altitude circular (160-250 nm)
- 16 days maximum duration
- Use existing power/data bus services
- Time-to-Flight: 1.5–2.5 years
- Flight Hardware recoverable

Shuttle Deployable

- 28 to 57° inclination
- 300 to 460 km altitude circular (160-250 nm)
- 3–12+ months duration dependent upon-orbit decay
- Dedicated power/data bus required
- Time-to-Flight: 2.5 years
- Flight Hardware potentially recoverable (e.g. Spartan)

Shuttle Deployable with Propulsion

- 28 to 57° inclination
- 300 to 600 km altitude circular (160-324 nm) or equivalent elliptical
- 12+ months duration
- Dedicated power/data bus required
- Time-to-Flight: 3 years
- Flight Hardware potentially recoverable (e.g. Spartan)

International Space Station

- 51.6° inclination
- 400 km altitude circular (215 nm)
- 12+ months duration
- Use existing power/data bus services
- Time-to-Flight: 2-3.5 years
- Flight Hardware recoverable

"Piggyback" Free-flyer on ELV

- TBD inclination (dependent upon host space vehicle)
- TBD altitude circular (dependent upon host)
- 12+ months duration
- Use existing power/data bus services
- Time-to-Flight: 5-7 years (dependent upon host launch schedule)

Dedicated Free-flyer on ELV

- Any inclination
- Any altitude
- 12+ months duration
- Dedicated power/data bus required
- Time-to-Flight: 2-7+ years

Briefing Length: The core time allotted to each presentation is 15 minutes. It is vital that each presenter adhere to this time limit to ensure the Board is able to view all pertinent information on all experiments.

Miscellaneous:

- Although the Board members receive a pre-meeting package containing each experiment's 1721-1 (STP Flight Request Executive Summary), presenters should brief all aspects of their experiment.
- Limit the number of acronyms, and spell out all that are used.

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ATTACHMENT F: EXPERIMENT REQUIREMENTS DOCUMENT (ERD) TEMPLATE

The following is a template for an ERD. Not all entries are required for all experiments. Each PI/PI should tailor the ERD to their experiment or program. PIs can contact STP at any time if they have questions when filling out the ERD.

EXPERIMENT REQUIREMENTS DOCUMENT

FOR

(EXPERIMENT NAME)

DRAFT of *(Date)*

Approved by:

____

(Principle Investigator) Date

INSTRUCTIONS -- PLEASE READ!!!

The purpose of an Experiment Requirements Document (ERD) is to document the requirements of your experiment to ensure that a successful spaceflight mission is achieved. It is the document in which you need to convey to the spacecraft builder and mission designer what your experiment "needs" during spacecraft development, integration, test, launch, and on-orbit operation. Once finalized, an ERD is often attached to a Request for Proposal (RFP) or other contractually binding documents. As such, it is critical that the final ERD be complete, concise, and unambiguous.

The purpose of the following ERD "template" is to serve as a guide and memory jogger. <u>Keep in mind you are documenting requirements from your experiment's perspective: What does the experiment require from the spacecraft to accomplish its objectives</u>? In some instances, suggestions on content and engineering units are provided (*in italics*) for your consideration. It is anticipated that you will need to tailor this template to meet your particular experiment's needs. Many of the suggested topic headings may be "not applicable" to your experiment. Similarly, you may need to add additional sections for special requirements not covered in this generic outline. Keep in mind that this template is intended to be a guide. Sample ERDs for other experiments are available for reference if needed.

If you do not have enough information to complete a section of the ERD, provide preliminary estimates if possible, but indicate that the information is preliminary and may change. It is also important that you provide information on any design and interface flexibility that you have. For example, you may be baselining a 1553 bus interface, but may be able to accommodate an RS-422 interface if the decision is made before CDR. Another example is that you may have two possible designs for an experiment antenna, and that either could be provided. The greater the flexibility in your experiment requirements, the greater the likelihood that your experiment will be manifested. In this regard, it is best to specify experiment requirements in three categories: “minimum acceptable”, “nominal” and “desired”.

Finally, as with any other technical document, a picture is worth a thousand words. Include pictures, drawings, schematics, timing diagrams, tables, etc. if they facilitate understanding of your experiment's requirements.

GOOD LUCK !!!

1. SCOPE

This document contains the specific requirements of the *[Experiment name]*. It provides experiment requirements in the following areas: physical and functional interfaces, spacecraft integration and test, launch systems, and on-orbit flight operations.

EXPERIMENT OVERVIEW

Experiment Description

The "big picture" of what your experiment does. This section should provide an overview, and details of operations should be contained in Section 9.2.3.

Describe the hardware and how it operates, and describe the scientific value and military relevance of the data being collected.

Experiment Objectives

List specific, concise objectives. Separate minimum objectives from desired objectives. Success criteria is defined in Section 2.5.

Operational Concept

How you propose to accomplish the objectives; e.g.:

- Operating all the time? If not, when?

- Routine, periodic ops (i.e. once per orbit) or uniquely scheduled ops?

- How much data do you collect per operation [kilobits (if discrete ops), or kilobits/orbit (if continuous)]

Are there different "modes" of operation?

Orbit Requirements

Standard orbit parameters

- Altitude at Apogee, (nm or km)

- Altitude at Perigee, (nm or km)

- Inclination, (degrees)

- Right ascension of the ascending node, (degrees) - if applicable

- Argument of perigee, (degrees) - if applicable

Should specify required parameters and acceptable tolerances, as well as desired parameters and preferences. Provide as much flexibility as possible.

Launch Window

Specific season (annual or solar cycle, time-of-day, sun angle, etc.)

Desired Mission Life

How long do you want to operate in orbit? (6 mos., 1 yr, 2 yrs, etc.) Note, STP can only fund up to 1 year of operations.

Success Criteria

What criteria will you use to judge the "success" of the mission?

- Define minimum acceptable and desired.

(These should relate to objectives listed in Paragraph 2.2.)

PHYSICAL DESCRIPTION
Engineering Layout
Pictures and/or drawings are helpful; show dimensions (cm).
Coordinate System
(if applicable)
Dimensions
Mechanical Interfaces
How will the experiment be attached to the spacecraft? Provide information for each box or unit of the experiment. What part of the interface will you provide and what do you expect the spacecraft contractor to provide? Typically, the spacecraft contractor provides the bolts, but the experimenter can specify requirements if necessary.
Electrical Connections
Number, location(s), and type(s) of connectors (power and data). Specify any thermistors that must be supplied and/or monitored by the spacecraft contractor.
Mass properties
Weight Summary
(kg)
Breakdown weights by box or unit. Include weight for connectors between experiment units. Mass for connections from spacecraft to experiment should *<u>not</u>* *be included.*
Center of Mass
Approximation is OK.
Mass Moment of Inertia
(kg-cm^2)
Moving parts
Consider both linear and angular motion:
- Range of motion (linear: cm ; angular: deg)
- Velocity (linear: cm/sec ; angular: deg/sec)
- Momentum (linear: kg-cm/sec ; angular: kg-cm^2 /sec or N-cm-sec)
Mounting and alignment
Is precision alignment to the spacecraft axes critical?
If so, specify alignment and/or alignment knowledge (in degrees).
Field of View Requirements
Specify field of view requirements (degrees) for each sensor, antenna or radiator surface.
Specify "keep out zones" and acceptable levels of intrusion, if applicable.
-- Diagrams are helpful.
Experiment Models / Simulators
Do you have any mass or electrical models you could supply to the spacecraft builder?
ELECTRICAL INTERFACE REQUIREMENTS
Electrical Power Requirements
Power Supply
(Volts dc) Include regulation requirements
Power Consumption
Specify: nominal, peak, and orbit average values (watts) for each unit.
If there is more than one mode, include a power profile for each. Use one or both of the example tables below, or modify them as needed.
Plot the power profile for a typical orbit/day/week of operation (as appropriate).

Experiment Unit or Box Name	Nominal Power (W)	Peak Power (W)	Average Power (W)
Photometer (Unit 1)	*10*	*12*	*10*

Table 4.1.2-1 Experiment Power Requirements **(EXAMPLE)**

Experiment Ops Mode	Power (W)	Ops Time per Orbit (minutes or % of orbit)	Frequency of Operations
Photometer Scan	*10*	*30 min (33%)*	*Once per orbit over perigee*
Photometer Standby	*1*	*60 min (67%)*	*Once per orbit*
Photometer Calibration	*10*	*10 min*	*Once every 60 days on-orbit*

Table 4.1.2-2 Experiment Operational Power Requirements **(EXAMPLE)**

Input/Output Signal Interfaces (Diagrams or simple schematics are helpful.)
Bi-Directional Interfaces (Command/Telemetry via spacecraft data bus)
If you require a bi-directional interface (MIL-STD-1553B, RS422, etc) with the spacecraft data bus, mention it here, but save the details for Paragraphs 5.0 & 6.0
Experiment Inputs (Discrete and Analog)
Inputs not covered in 4.2.1; i.e. overrides, by-pass commands, external clocks, etc.
Experiment Outputs (Discrete and Analog)
Outputs not covered in 4.2.1; i.e. "state of health" data, temperature sensors, power monitors, error flags, etc.
COMMAND AND CONTROL
Command Interface
"Standard" interface (MIL-STD-1553, RS-422, etc..) if applicable.
- Specify design preference and available options.
Spacecraft Command and Data Handling
What must the spacecraft be capable of?
- Number of commands, command length (bits, bytes), real-time vs. stored commands, transmission delays (seconds)
Clock/Time reference requirements
Does the spacecraft need to provide a time reference to the experiment? If so, specify the format, rate (how often), accuracy, and reference standard (e.g. UTC)
TELEMETRY AND DATA HANDLING

Telemetry System
"Standard" interface (MIL-STD-1553, RS-422, etc..) if applicable
- Specify design preference and available options.
Experiment Data Collection & Storage
- The rate at which science data is collected (e.g. kbits/orbit or kbits/operation). Be sure that experiment ops modes correspond to the ops modes given for power consumption (Section 4.1.2) and experiment ops (Section 9.2.3).
- Specify the experiment's storage capacity (kbits), if applicable.
Experiment Data Transfer
Is science data passed to the spacecraft for downlink... or does the experiment have its own transmitter/antenna?

Experiment Data Download Requirements
How much data must be passed to the ground
- e.g. kbits/orbit, kbits/day, etc.
State any hard requirements that affect real-time spacecraft operation
- e.g. "Data from (event #1) must be down-loaded at least (x) hours prior to (event #2) to meet operations planning requirements.
Data Transfer
- Rate at which the experiment will pass data to spacecraft
buffer (kbits/second) and the protocol to be used.
Data Integrity
Acceptable bit error rate
Spacecraft Data
What data do you need from the spacecraft?
- e.g. spacecraft attitude, position, time, experiment and/or spacecraft command history, etc...
- Does the experiment need this data in real-time, or do you need it only for post-processing?
ENVIRONMENTAL REQUIREMENTS
In addition to launch and on-orbit considerations, you should also take into account requirements for ground handling, transportation, spacecraft integration/test, and launch vehicle integration/test.
Static Load Constraints
Can other payloads be mounted on the experiment?
Vibration Constraints
Tabular list or graph of rms acceleration (g^2 / hz) vs frequency (hz). Can put in a general statement such as "The experiment will be designed to meet the launch environment of a Pegasus, Taurus, LMLV, Delta (etc.) launch vehicle.". Information about these launch vehicle environments is available upon request.
Shock Constraints
Tabular list or graph of peak shock (g's) vs frequency (hz). Can put in a general statement as described in Section 7.2.
Radiation Constraints
Specify acceptable radiation dose levels (krads) and/or shielding requirements. Also specify any radiation sources in your experiment.

Electromagnetic Compatibility
Radiated Emissions from Experiment
Amplitude (micro-Volts/meter) vs frequency (MHz)
Conducted Emissions from Experiment
Amplitude (micro-Volts/meter) vs frequency (Mhz)
Magnetic Fields Generated by Experiment
Field strength (micro-Tesla) at distance (meter)
Sensitivity of Experiment to Radiated Emissions
Sensitivity of Experiment to Conducted Emissions
Sensitivity of Experiment to Magnetic Fields
Atmospheric Pressure Constraints
Depressurization rate (psi/sec) during launch and/or restrictions during testing (e.g., Experiment high voltage must only be turned on in a vacuum).
Cleanliness Constraints
Cleanroom requirement (e.g. Class 100,000)
Outgassing considerations
Humidity Constraints
Relative humidity as a function of temperature
Thermal Interface Requirements
Thermal Isolation *(watts)*
Incident Thermal Flux *(watts/ft^2)*
INTEGRATION AND TEST
Spacecraft Integration and Test
Pre-spacecraft Integration Inspection & Test
Explain inspection/testing required when experiment is received at spacecraft integration facility. Typically, a functional test of the experiment is performed before integration to assure that the experiment was not damaged during shipping.
Post Spacecraft Integration Test Requirements
Usually a full experiment functional test is performed to assure that integration was successful.
Ground Support Equipment (GSE) and Facilities
Explain any specialized equipment needed. Specify what you will provide and what you expect the spacecraft integrator to provide. (e.g., office space, anechoic chamber, etc.).
Ground Handling Procedures
Refer to environmental restrictions in Section 7 if appropriate. Specify any unique precautions that must be taken.
Launch Vehicle (LV) Integration and Test
LV Integration Site Tests
Often a functional test of the experiment is possible before spacecraft integration to the launch vehicle.
LV Integration Site GSE and Facilities
Include environmental requirements
Launch Pad Tests
Often, not much can be done with the experiments at this point.
Launch Pad Environment
Experiment Access

Is access to any part of the experiment required? Why?
Launch Go/No-Go Criteria
Potentially Hazardous Materials & Equipment
Pressurized Systems (Liquid/Gas)
Ordnance Systems
Radiation Sources
High Voltage Source Locations
Experiment Safety During Integration and Test
ON-ORBIT OPERATIONS REQUIREMENTS
Launch Phase Requirements
Include orbit transfer operations, if applicable.
On-Orbit Operations
Initialization
What needs to be done to the experiment prior to the first operation? (e.g., check temperatures, outgassing for 3 hours, etc.)
Check-Out
What will be done to initially check out the experiment on-orbit?
Experiment Ops
Describe the nominal experiment operations over the life of the mission? Provide the details of Section 2.3. Be consistent with the ops modes given in Sections 4.1.2 (power) and Section 6.2 (data).
Experiment Turn-On
Required sequence of events and timing constraints (e.g., outgassing, warm-up, etc.)
Operations Support
Pre-Flight Training and Simulation
What are you able to support? What do you expect from the spacecraft contractor?
Data Return, Processing, and Distribution
Meteorological Services
ON-ORBIT ORIENTATION AND STABILIZATION
Attitude Control
Type required (e.g. spin, 3-axis, earth pointing, etc.)
Acceptable pointing accuracy (deg) and drift rates (deg/sec)
Attitude Knowledge
How accurately do you need to know platform orientation (deg) and drift rate (deg/sec)?
- Specify real-time or post-processed requirement
EPHEMERIS DATA
Prediction/Real Time Knowledge
Specify required in-track (km), cross-track (km) , and altitude (km) accuracies. For example, "spacecraft ephemeris predictions are required 2 weeks before experiment operations to an accuracy of 10 km in-track and cross-track and 20 km altitude".
Post Processed Knowledge
Specify required in-track (km), cross-track (km) , and altitude (km) accuracies. For example, "spacecraft ephemeris data must be provided to the experiment PI within 1 week following experiment operations to an accuracy of 5 km in-track, cross-track and altitude".
12. SCHEDULE

Provide experiment development milestones (PDR, CDR, etc.) and the date the hardware will be ready for integration to the spacecraft.

Experiment design and delivery dates are given in the ERD for information only and are not contractually binding dates.

SECURITY

Address all security concerns and safeguarding requirements related to the experiment, to include: experiment hardware/software design, physical access to the hardware, classification of experiment science data (both raw data and processed data), etc. Identify any issues associated with manifesting the experiment on a foreign spacecraft.

LIST OF ACRONYMS

REFERENCES *(if any)*

ATTACHMENT G: FUNDING AND SUPPORT CERTIFICATION LETTER TEMPLATE

The format for the Funding and Support Certification Letter, which is submitted by the Principal Investigator's organization, is seen below.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE SYSTEMS CENTER (AFSPC)
LOS ANGELES AIR FORCE BASE, CALIFORNIA

12 November 2004

MEMORANDUM FOR DOD SPACE TEST PROGRAM
SMC/Det-12/STATTN: COL "BLANK"
3548ABERDEEN AVE SE
KIRTLAND AFB NM 87117

FROM: [Budgetary Authority in PI's organization]

SUBJECT: Funding and Support Certification for [payload]

1. [PI's organization] certifies funding and personnel are available and programmed to support all [PI's organization] responsible costs and duties associated with the proposed STP flight of [payload], except as noted below.

2. The following table identifies funding programmed and required ($M) for the [PI's organization] [payload] program:

Funding source	FY #1	FY #2	FY #3	FY #4	FY #5	FY #6	Total
[PI's organization]							
[e.g., AFSPC]							
[e.g., OSD]							
[e.g., contractor]							
[e.g., other]							
Total programmed							

Total required							
Delta							

3. [PI's organization] plans to resolve the delta between total funding programmed and total funding required by the following program action(s):

   a. …

4. [PI's organization] has assigned [name] to the [payload] program as the Principle Investigator (PI). [He/She] will be dedicated to the program and will work [his/her] team to ensure [PI's organization] supports the needs of STP in accordance with a Memorandum of Agreement (MOA) that will be signed at a later date. [PI's name] can be reached at [phone number] or [email address].

5. As STP actively pursues flight options for [payload], [PI's organization] will provide the necessary support, including funding and personnel, to ensure a successful mission for the [payload] program, [PI's organization], and STP. Contact [budgetary authority in PI's organization] at [phone number] or [email address] if you have any questions.

[Budgetary Authority in PI's organization]

ATTACHMENT H: PRINICIPAL INVESTIGATOR – SPACE TEST PROGRAM MEMORANDUM OF AGREEMENT

The following is a recommended template for a MOA between a PI and STP. If this document is printed in color, entries in BLUE enclosed in brackets and italicized e.g., [*EXPERIMENT*] indicate information to be filled in with the appropriate, experiment-specific information. If not printed in color, then entries enclosed in brackets and italicized e.g., [*EXPERIMENT*] must be filled in.

MEMORANDUM OF AGREEMENT

BETWEEN

THE USAF SPACE AND MISSILE SYSTEMS CENTER

DETACHMENT 12/ST

DoD SPACE TEST PROGRAM

AND

[*The SPONSOR*]

FOR

THE INTEGRATION, LAUNCH, AND SPACEFLIGHT OF

[*XYZ-0401*] EXPERIMENT

ON THE [*P05-2*] MISSION

XX August XXXX

FOR [*THE SPONSOR*]:

______________________________________ Date: _______________

[*Dr. John P. Smith*
Associate Director of Research
The SPONSOR]

FOR DET-12/ST, DoD SPACE TEST PROGRAM:

______________________________________ Date: _______________

Richard W. White, Colonel, USAF
Director, Space Test Program

TABLE OF CONTENTS

MEMORANDUM OF AGREEMENT

1.0 PURPOSE

This Memorandum of Agreement (MOA) delineates the roles and responsibilities between the Space and Missile Systems Center (SMC), Department of Defense (DoD) Space Test Program (SMC Det 12/ST or STP) and the [*SPONSOR*] for integration, and spaceflight of XYZ-0401, [*EXPERIMEN*T]. The basic guidance for this document is AFI 10-1202(I)/AR 70-43/OPNAVISNT 3913.1A, “Space Test Program Management”, 01 Apr 98.

2.0 SCOPE

This MOA shall establish the basic working agreements between STP and the [*SPONSOR*] for the integration and single spaceflight of [*XYZ-0401 (EXPERIMENT)*] on an STP-provided spacecraft, hereafter referred to as [*THE MISSION*]. The [*MISSION*] will be launched and operated via STP-provided capabilities. This MOA shall define the responsibilities of STP and the [*SPONSOR*] and shall be effective upon the date of the final signatures of both parties. After SAF/USA approval of the Space Flight Plan (SFP), withdrawal of an experiment requires notification to USA by the withdrawing experiment’s agency.

This MOA will be reviewed annually and amended as required. It will automatically terminate upon program completion or five years from the date of origination, whichever occurs first. Termination in advance of this agreed expiration date can be made by either party but shall require 180 days advance written notification by the withdrawing party. Should the [*SPONSOR*] be the withdrawing party, the [*SPONSOR*] shall reimburse STP for all incurred and termination costs attributable to the action of withdrawal.

The experiment requirements for [*EXPERIMENT*] will be contained in the [*EXPERIMENT*] Experiment Requirements Document (ERD), dated XXX, and will be coordinated with both STP and the [*SPONSOR*].

3.0 SPECIFIC RESPONSIBILITIES

3.1 STP:

3.1.1 Mission and Operations Management

3.1.1.1 STP will manage all aspects of space vehicle (SV) and launch vehicle (LV) procurement, will provide the Mission Director for the mission, and will manage the flight operations team and all phases of operational readiness, SV integration, LV integration, and one year of on-orbit operations.

3.1.1.2STP shall manage all risks that could jeopardize the success of the mission. These will include:

- Define the interfaces and acceptable testing standards between [*EXPERIMENT*] and the SV and between [*THE MISSION*] and the ground flight operations system.
- Plan, manage, lead the execution of, and approve the results of compatibility testing between [*EXPERIMENT*] and the SV with inputs from [*THE SPONSOR*], and the SV contractor.
- Lead mission operations planning efforts to minimize risk to the missions and to ensure adequate preparation by the flight operations team.
- Concur with the decision to ship the SV to the launch integration site after demonstration that all required testing has been completed satisfactorily.
- STP shall have the authority to disapprove the flight of [*EXPERIMENT*] if it has not been tested/constructed per all signed/approved Interface Control Documents (ICDs), or if any problem is uncovered which will jeopardize the success of the mission. This includes unacceptable technical, schedule, or cost risk.

3.1.1.3 STP shall manage the master schedule for operations readiness, [*EXPERIMENT*] delivery, SV integration, LV integration, and launch. This will include management of readiness, resource conflicts, and training schedules through coordination with both [*THE SPONSOR*] and the SV contractor. The STP Mission Director has authority to resolve all schedule conflicts involving readiness, SV integration, LV integration, on-orbit checkout, and nominal operations.

3.1.1.4 STP shall participate in [*EXPERIMENT*] program reviews, experiment technical design, fabrication, test, and operations planning as required to manage SV integration, LV integration, flight operations planning, and overall mission schedules.

3.1.2 Launch and Integration

3.1.2.1 STP shall integrate the [*EXPERIMENT*] payload onto the SV, which will support the negotiated [*EXPERIMENT*] requirements according to the Mission Requirements Document (MRD).

3.1.2.2 STP shall provide launch services and support to place the SV into the required orbit as defined in the SFP.

3.1.2.3 STP shall define and manage interfaces from the mission to the LV including any STP-provided adapters. This includes the necessary operational, electrical, mechanical, and environmental interface data required to support design, build, integration, and testing.

3.1.2.4 STP shall approve/disapprove waiver requests to ICD's between [*EXPERIMENT*] and any other mission element, i.e. SV, AFSCN, RSC, etc. This includes compliance with LV safety requirements.

3.1.3 Mission Operations

3.1.3.1 STP shall provide a Mission Director or designee to lead [*THE SPONSOR*] and the Spacecraft Operations Center (SOC) in mission operations planning, operations readiness, pre-flight compatibility-verification tests, and the first year of on-orbit operations support. The Mission Director has the authority and ultimate responsibility for the safe and successful conduct of the mission.

3.1.3.2 STP shall provide for one year of flight operations support to include:

- A SOC to support real-time flight control operations including command generation, orbit determination, and telemetry processing required for real-time control.
- Raw experiment data and processed spacecraft data will be provided to the [*EXPERIMENT*] Payload Operations Center (POC) for post-pass processing and analysis. STP cannot guarantee the recovery of all experiment data and cannot be held liable for lost data,
- Monitoring and management of SV systems to maximize experiment and mission success.

3.1.3.3 STP shall provide for flight operations support beyond the first year if requested and funded by [*THE SPONSOR*].

3.1.3.4 STP shall obtain frequency allocation approvals for the mission.

3.1.3.5 STP shall provide a SV contractor-validated end-of-life plan, developed with [*THE SPONSOR*] input, for execution when operations are terminated and/or the spacecraft is no longer usable.

3.1.4 Security

3.1.4.1 STP shall provide for overall safety, security, environment, quality assurance, and compatibility test functions for [*EXPERIMENT*] as required. This does not include items or functions internal to [*EXPERIMENT*], or [*THE SPONSOR*]-provided GSE elements.

3.2 [*THE SPONSOR*]:

3.2.1 Flight Experiment

3.2.1.1 [*THE SPONSOR*] shall fund, manage, develop, test, and deliver the flight-ready [*EXPERIMENT*] payload to the SV contractor for integration onto the SV according to the STP master schedule.

3.2.1.2 [*THE SPONSOR*] shall ensure that [*EXPERIMENT*] meets all interface requirements for integration, launch and flight operations. These include:

- Design all required interfaces to the SV according to the [*EXPERIMENT*]-to-SV ICD specifications.
- Design all [*EXPERIMENT*] specific required interfaces with the ground flight operations system according to the mission-to-Ground ICD.
- [*THE SPONSOR*] shall be responsible financially and technically for resolving any issues that are the result of non-compliance with established ICDs.
- [*THE SPONSOR*] shall contribute to the development of the experiments-to-SC bus ICDs. Current [*EXPERIMENT*] -to-SC bus ICD's shall be provided by STP.

3.2.1.3 [*THE SPONSOR*] shall comply with program and LV safety, security, environmental, and integration requirements, and provide data as necessary for safety, security, and flight certifications.

3.2.1.4 [*THE SPONSOR*] shall provide space-qualified mass models, upon STP request if the flight unit is unacceptable for flight. Such mass models shall be delivered on the same schedule the [*EXPERIMENT*] flight model would nominally follow.

3.2.1.5 [*THE SPONSOR*] shall provide mass/volume models, upon STP request, to the SV contractor for testing.

3.2.1.6 [*THE SPONSOR*] shall hold a pre-ship review with STP approximately one week prior to shipment of [*EXPERIMENT*] to the SV contractor integration site to ensure that all issues are resolved. [*THE SPONSOR*] shall demonstrate mission readiness prior to shipment.

3.2.1.7 [*THE SPONSOR*]shall provide an [*EXPERIMENT*] C&DH simulator to the SV contractor to interface with their FLATSAT simulator.

3.2.2 Mission Operations

3.2.2.1 [*THE SPONSOR*] shall provide resources for processing experiment telemetry, generating experiment timelines, generating experiment command uploads, to support the STP-provided SOC operations. These resources will be provided for the life of the mission.

3.2.2.2 [*THE SPONSOR*] shall provide, maintain, and operate all [*EXPERIMENT*] GSE required by STP for conduct of [*EXPERIMENT*] integration to the SV, mission-to-SOC compatibility testing, SV integration to the LV, launch site testing, and on-orbit operations. [*THE SPONSOR*] shall also provide logistical and operational support of [*EXPERIMENT*] flight hardware/software during this testing and on-orbit operations.

3.2.2.3 [*THE SPONSOR*] shall support the mission contractor generated and configuration-controlled command and telemetry databases and their delivery to STP according to the master STP mission schedule. [*THE SPONSOR*] shall support the delivery of updated databases to STP before SV launch base compatibility testing.

3.2.2.4 [*THE SPONSOR*] shall provide technical support to the STP flight operations team for one year after launch, as required. This will include support for launch and early operations (L&EO), nominal operations, contingency operations, and anomaly resolution.

3.2.3 Support

3.2.3.1 [*THE SPONSOR*] shall support reviews, tests, and operational rehearsals as required by STP to effectively manage the mission.

3.2.3.2 [*THE SPONSOR*] shall support STP in development and review of all documents necessary to effectively manage the mission. Failure to meet the required delivery dates may result in liability for any resulting slip in the mission schedule.

3.2.3.3 [*THE SPONSOR*] shall provide experiment training for the entire mission operations team including:

- Appropriate personnel, expertise, and training materials
- Support of rehearsal preparations to include generation of experiment anomaly scripts
- Support of rehearsal execution, as required, to include personnel and equipment to execute experiment anomaly scripts and to generate simulated experiment telemetry, if appropriate.

3.2.3.4 [*THE SPONSOR*] shall conduct quarterly program reviews/technical interchange meetings to address the schedule, budget, and performance of the project.

3.2.3.5 [*THE SPONSOR*] shall distribute, reduce, analyze, and report to STP on the experiment data received from the mission. Specifically this will include reports required by AFI 10-1202(I), including, but not limited to:

- A completed 1721-2 or "Final Report" submitted no later than (NLT) one year after the completion of the STP sponsored one year of mission operations.
- Presentation of flight results at the next available STP Sponsored Data Exchange, upon completion of the STP sponsored one year of mission operations
- Any published papers about the experiment should also be sent to STP for inclusion in the STP Library.

3.2.3.6 [*THE SPONSOR*] shall be responsible for providing funding for any on-orbit operations and data product generation beyond one year. [*THE SPONSOR*] must provide notice to STP NLT 90 days prior to the termination or extension of operations. [*THE SPONSOR*] shall be responsible for paying all costs associated with transferring [*THE MISSION*] on-orbit operations to another facility should that be desired.

4.0 TECHNICAL REQUIREMENTS

The technical requirements for the experiment and its interface to the spacecraft are found in the MRD.

5.0 MAJOR EXPERIMENT MILESTONES

[*THE MISSION*] master schedule shall be established and maintained by the SV contractor. The experiment schedule shall be established and maintained by [*THE SPONSOR*]. The designated operations center development shall be established and maintained by STP; in the case of the RSC, SMC Det 12/VO shall be responsible for development and maintenance. It shall be the joint responsibility of STP and [*THE SPONSOR*] to ensure consistency between various schedules and notify other parties whenever a schedule change occurs. Schedule changes may result in cost impacts according to the responsibilities outlines in Section 6. The following milestones are considered critical to the mission and are subject to change:

a. [*EXPERIMENT*] sensor system requirement review (SRR) XXXX

b. [*EXPERIMENT*] sensor preliminary design review (PDR) XXXX

c. [*EXPERIMENT*] sensor critical design review (CDR) XXXX

d. [*EXPERIMENT*] sensor delivery to spacecraft contractor XXXX

e. [*THE MISSION*] spacecraft/sensors integration delivery XXXX

f. Satellite launch XXXX

6.0 PROGRAM FUNDING

6.1 STP FUNDING

STP will fund all integration costs incurred by the incorporation of [*EXPERIMENT*] into the SV, excepted as noted in paragraphs 6.2 and 6.3. STP will also fund SMC/Det 12 VO for the retrieval of flight ephemeris, spacecraft attitude, flight history, flight engineering, and raw experiment data for the first twelve months of space operations. STP will not fund for experiment development or the reduction and analysis of the raw data.

6.2 [*SPONSOR*] FUNDING

[*THE SPONSOR*] will fund the space qualified instrument development and fabrication, instrument ground and flight technical support, peculiar instrument support equipment, and space flight data reduction/analysis. Per AFI 10-1202(I)/AR 70-43/OPNAVISNT 3913.1A, [*THE SPONSOR*] shall reimburse STP for any increase in cost incurred as a result of [*EXPERIMENT*] delays, changed experiment requirements as established by this MOA and the approved ICDs baseline, or damage to support hardware caused by the [*THE SPONSOR*]. Moreover, the [*THE SPONSOR*] shall reimburse STP for any pre-launch integration, test, and scheduling costs incurred due to experiment caused failures. Historically, costs for such delays have been significant - upwards of $100,000 per week.

6.3 [*THE SPONSOR*] or STP WITHDRAWL

Withdrawal shall be accomplished by written notification to SAF/USA and signed by appropriate authority. Also per AFI 10-1202(I)/AR 70-43/OPNAVISNT 3913.1A, [*THE SPONSOR*] shall reimburse STP for all incurred and termination costs should [*EXPERIMENT*] be withdrawn voluntarily by [*THE SPONSOR*] from the mission.

6.4 MISSION DELAYS

In the event that the mission experiences delays due to the satellite or launch vehicle, STP will provide funding to the affected satellite or launch vehicle contractor.

7.0 POINTS OF CONTACT

STP:
[*Capt Jane Doe*
3548 Aberdeen Ave SE
Kirtland AFB, NM 87117-5778

(505) 846-8704
DSN 246-8704
FAX: 8899]

[*The SPONSOR:*
Dr. Bill Smith
XYZ Laboratory
Washington, D.C. 12345-6789

(123)456-7890
FAX: 5555]

8.0 INFORMATION RELEASE

The Space and Missile Systems Center Office of Public Affairs (SMC/PA), or its designated representative, has the primary responsibility for public release of any information associated with this mission (as opposed to experiment data) and such release will be in compliance with existing DOD directives and security classification guides. The STP Information Plan, 75-4 (available from SMC/PA) provides policies and procedures for releasing public information about STP missions. Any public release concerning this effort will identify it as a Department of Defense Space Test Program mission containing a [*SPONSOR*] experiment.

[*THE SPONSOR*] shall comply with DoD Directives 5230.24 and 5230.25 on public release of sensitive/unclassified technical information.

[*THE SPONSOR*] shall submit two copies of any material scheduled for public release concerning integration, operations, or the terms and conditions of this MOA in writing to STP prior to presentation/publication. STP shall review the material and forward it along with its recommendation for release to SMC/PA for final approval, and shall complete the process in a reasonable time frame.

Release of experiment data, analyses, and conclusions need not be approved by SMC/PA, but public release must be in accordance with [*THE SPONSOR's*] release procedures, applicable security directives and classification guidelines, and host-tenant agreements. The public release shall state the experiment was integrated and flown by the DoD Space Test Program. Such statement will not require STP and SMC/PA coordination. However, any additional statements made in the areas specified in previous paragraphs will require review and approval.

ATTACHMENT I: DD FORM 1721-2 AND INSTRUCTIONS

This attachment contains a blank form to be downloaded and the instructions for filling out the blocks for DD Form 1721-2. This form can be downloaded from the SAF/USA website at http://www.safus.hq.af.mil/usa/usal/serb/index.htm, or can be obtained in electronic form from STP.

SPACE TEST PROGRAM AFTER ACTION REPORT		CLASSIFY BY	DECLASSIFY BY
1. EXPERIMENT TITLE		2. SHORT TITLE	
3. EXPERIMENT NUMBER	4. SPONSOR	5. DATE OF SUBMISSION *(YYYYMMDD)*	6. DATE OF REVISION *(YYYYMMDD)*
7. OBJECTIVE			
8. FLIGHT DATA			
a. LAUNCH DATE *(YYYYMMDD)*	b. MISSION DURATION *(Mission/Experiment)*		c. LAUNCH VEHICLE
d. LAUNCH SITE	e. HOST VEHICLE/PLATFORM		f. INCLINATION
g. ORBIT *(km)* APOGEE + - PERIGEE + -	h. SPECIAL CHARACTERISTICS		
i. EXPERIMENT COST	j. EXPERIMENT WEIGHT *(kg)*	k. EXPERIMENT VOLUME *(cc)*	l. NOMINAL/PEAK POWER *(w)*
m. PICTURE OF EXPERIMENT			

DD FORM 1721-2, JUL 1997(EG) PREVIOUS EDITION IS OBSOLETE. PAGE 1 OF 4 PAGES
Designed using Perform Pro, WHS/DIOR, Jul 97

EXPERIMENT DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

13. DESCRIPTION OF POTENTIAL RESULTS

14. FOLLOW-ON PLANS

15. EXPERIMENTER AGENCY

a. PRINCIPAL INVESTIGATOR *(Last Name, First, Middle Initial)*	b. ACTIVITY	c. POSITION
d. MAILING ADDRESS *(Street, Apartment/Suite No., City, State, ZIP Code)*	e. TELEPHONE NUMBER(S) *(Include Area Code)* COMMERCIAL	DSN
	f. SIGNATURE	

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EXPERIMENT DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

13. DESCRIPTION OF POTENTIAL RESULTS

14. FOLLOW-ON PLANS

15. EXPERIMENTER AGENCY

a. PRINCIPAL INVESTIGATOR *(Last Name, First, Middle Initial)*	b. ACTIVITY	c. POSITION
d. MAILING ADDRESS *(Street, Apartment/Suite No., City, State, ZIP Code)*	e. TELEPHONE NUMBER(S) *(Include Area Code)* COMMERCIAL	DSN
	f. SIGNATURE	

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EXPERIMENT DATE *(YYYYMMDD)*	EXPERIMENT TITLE	EXPERIMENT NUMBER

16. MISSION PROGRAMMATIC DATA *(To be filled in by STP SPO)*

a. MISSION NUMBER/NAME	b. MISSION COST	c. MISSION OPR/INTEGRATING CONTRACTOR(S)
d. LIST OF COMPANION EXPERIMENTS	e. PAYLOAD WEIGHT *(kg)*	
	f. PAYLOAD VOLUME *(cc)*	g. POWER REQUIREMENTS *(w)*
h. AUTHORIZED STP SPO OFFICIAL *(Last Name, First, Middle Initial)*	i. SIGNATURE	j. DATE *(YYYYMMDD)*

k. DESCRIPTION OF MISSION

l. PICTURE OF SPACE VEHICLE SYSTEM CONFIGURATION

m. SPACECRAFT AND/OR EXPERIMENT ANOMALIES

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INSTRUCTIONS FOR COMPLETING DD FORM 1721-2

SPACE TEST PROGRAM AFTER ACTION REPORT

1.1. General Information. The Space Test Program After Action Report requests information required by management for "quick look" understanding and evaluation of a flight experiment. The After Action Report will describe the data obtained, results, use of data, and indication of potential DoD benefits to be accrued. These reports facilitate conducting long-term "DoD Benefits Accrued from STP" studies, along with becoming helpful in management and execution of the Space Test Program.

Upon spaceflight of an experiment, principal investigators and/or sponsors are required to provide experiment spaceflight results by submitting a DD Form 1721-2 Space Test Program After Action Report to the STP Program Office, SMC Det 12/ST, as follows*:

a. Preliminary report not later than six months after launch.
b. Updated status report annually thereafter upon submission of preliminary report.
c. Final report six months after completion of experiment mission.
d. Additional reports will be provided, if necessary, upon mutual agreement between SMC Det 12/ST and the principal investigator and/or sponsors. (*The above-indicated schedule applies for a multiyear mission. Shorter duration missions will adjust accordingly, e.g., a 1-week mission only submits a final report, whereas, a 1-year mission submits both preliminary and final reports.) Upon SMC Det 12/ST receipt of this report, SMC Det 12/ST is required to complete Section 16 Mission Programmatic Data Section of DD Form 1721-2 and submit within 30 days the entire report to the Director, Space Acquisition, SAF/USA.

1.2. Security Classification. The form will be marked with a security classification commensurate with the highest classification of any single entry. For a classified form, the security classification of each block must be indicated such as (S) for SECRET. The downgrading block (Classified by:/Declassify On:) must also be completed.
1.3. Instructions for Completing Specific Items: NOTE APPLYING TO ITEMS 7 THROUGH 16: Information in some of these items may not change from the initial submission of DD Form 1721-2. In this case, indicate "No Change." Any changes from previous report submissions, however, should be highlighted.

a. Item 1. Experiment Title. Indicate the full descriptive experiment title as originally identified on DD Forms 1721 (Space Test Program Flight Request), and 1721-1 (Space Test Program Flight Request-Executive Summary). Nicknames, equipment nomenclatures, acronyms, etc., will not be used.
b. Item 2. Short Title. Indicate the experiment nomenclature, acronyms, and nicknames as originally identified on DD Forms 1721 and 1721-1.
c. Item 3. Experiment Number. Indicate the experiment number as originally assigned on DD Forms 1721 and 1721-1.
d. Item 4. Sponsor. Indicate the organization/directorate/office symbol of the sponsoring agency.
e. Item 5. Date of Submission. Self-explanatory.
f. Item 6. Date of Revision. Self-explanatory.
g. Item 7. Objective. Describe what was to be accomplished. If there was more than one objective, treat each one separately. If the objective was classified, an unclassified version must also be included, if possible.

h. Item 8. Flight Data. Indicate the launch date (YYYYMMDD) and mission duration starting from turn-on of the host payload mission as well as the operational duration of the experiment starting from initialization. Also indicate the launch vehicle (e.g., Atlas II, Pegasus, etc.), the launch site (e.g., Vandenberg Air Force Base, Cape Canaveral Air Station, etc.), and the host vehicle/platform (e.g., STEP, GPS, DMSP, SPOT, etc.). Also provide the experiment/mission orbit apogee, perigee, and inclination (in degrees). Include any other special characteristics, such as circularity, sun synchronous orbits, etc. Indicate the total experiment (only) cost. Total cost includes all funds expended by the sponsoring agency and all other agencies, businesses, etc. supporting the development of the experiment or spacecraft, i.e., prototype, hardware, staff costs, and data reduction. Indicate the experiment's weight, volume, and nominal and peak power levels. Include a descriptive picture of the experiment with physical dimensions and major component names indicated.

i. Item 9. Evaluation of Meeting Experiment Objectives. Evaluate how successful the experiment was in terms of meeting its original objectives. If possible, quantify in terms of a percentage the amount of objectives met. Discuss which objectives were not met and why. Also discuss whether or not the experiment was properly designed to obtain the desired data.

j. Item 10. Description of Data and Preliminary Results Obtained. Describe what types of data and preliminary results were obtained. Discuss any validation results, discoveries, unexpected data behavior, conclusions, etc.

k. Item 11. Description of Data Utilization. Discuss how the data are being (were) used.

l Item 12. Plan for Data Processing and Dissemination of Results. Describe how the data will be processed and results disseminated to potential users. Include also presentations at conferences and publications in journals, etc.

m. Item 13. Description of Potential Benefits. Describe the benefits that were (or can be) derived from the obtained data. Consider the following questions as a guide in the development of your narrative, as applicable.

(1) Where will the experiment results ultimately lead to in terms of improved military subsystems, atmospheric models, systems performance, etc.?
(2) What is the relation to exploratory development or operational systems development programs?
(3) For hardware developments and demonstrations, forecast results accruing, including potential operational applications or improvements in present operational systems performance.
(4) For exploratory development efforts, forecast the improvement in technology that is anticipated. Discuss how the proposed technology will be better than existing technology.
(5) What is our present knowledge or capability in this area? What is the current state-of-the-art?

n. Item 14. Follow-on Plans. What, if any, follow-on work is planned because of the results obtained from this experiment? What is the next step once this experiment is flown/completed and/or the data is processed? Identify additional spaceflights anticipated. Does the present experiment require more than one flight?

o. Item 15. PI Agency Data. Include the signature from the Principal Investigator who was the primary contact to STP for the experiment. The name block should include rank (if military) or title. Include full mailing address and commercial and/or DSN phone numbers.

p. Item 16. Mission Programmatic Data (To be filled in by the STP Program Office). Provide the mission number and name that included this particular experiment. Indicate the total cost incurred by the Space Test Program (includes satellite procurement, integration, launch and mission operations support, and data retrieval costs but excludes STP Program Office and Aerospace personnel costs), and the name of the OPR/Prime Integrating Contractor(s) for this mission. List the companion STP experiments (experiment number and title), if any, that accompanied this experiment on this mission and the total payload weight, volume, and power requirements. A signature is also required from the authorized STP Program Office official. The name block should include rank. Include a description of the mission and a picture of the space vehicle system configuration with physical dimensions and experiments indicated. Attach transparencies/color photographs, if available. Indicate any spacecraft and/or experiment anomalies.